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PROCEEDINGS

of the

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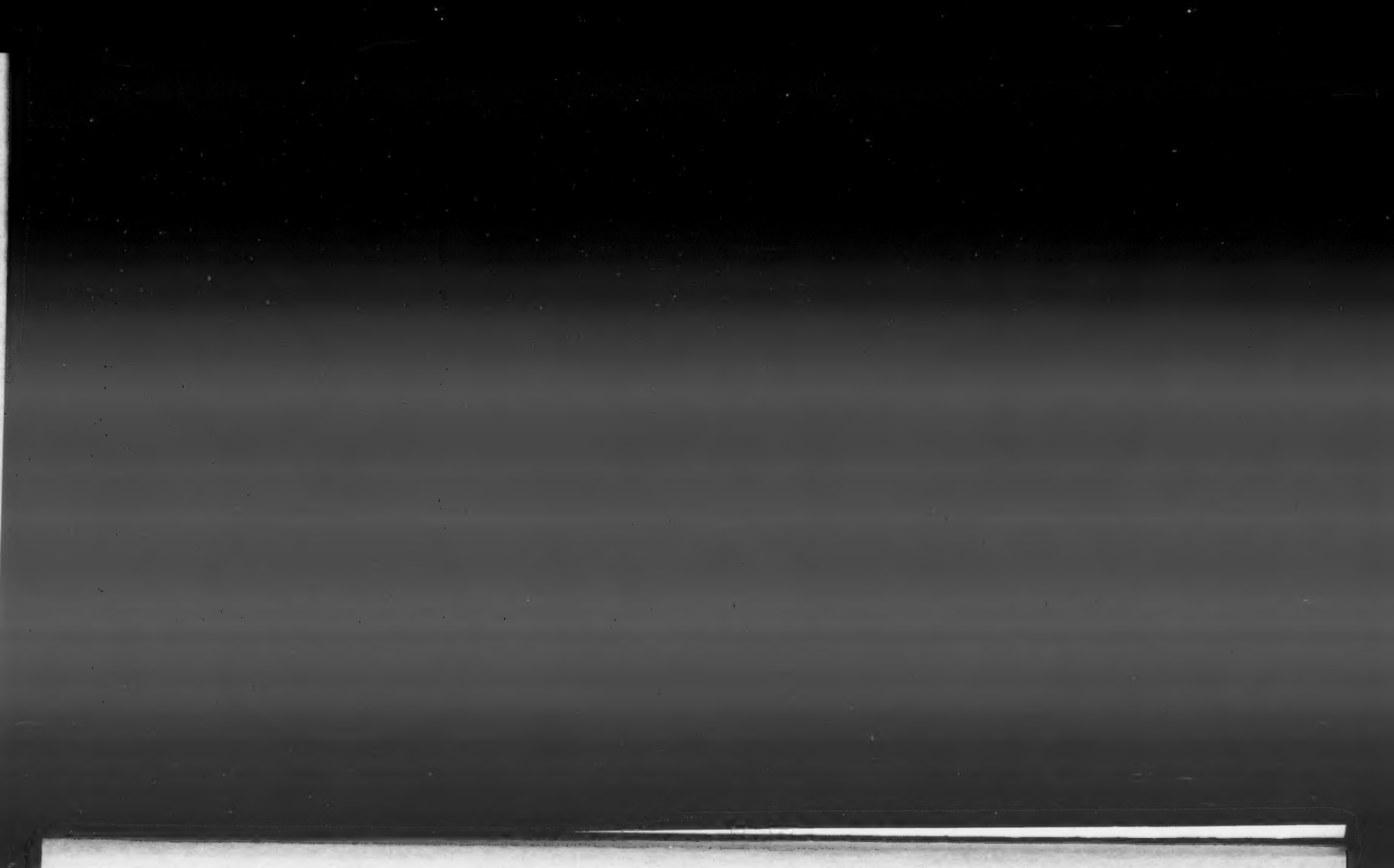

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ACARICIDE TRIALS IN BRITISH COLUMBIA ORCHARDS, 1950[1]

R. S. DOWNING[2]
Dominion Entomological Laboratory, Summerland, B. C.

Although the two acaricides parathion and monoethanolamine dinitro-o-cyclohexylphenolate, presently being recommended for British Columbia orchards, are reasonably effective, each has shortcomings that mark it for replacement as soon as possible. Parathion, first recommended for the control of orchard mites in 1949, has a serious disadvantage in its high toxicity to mammals. Furthermore, it lacks specificity and it is not sufficiently effective against the Willamette mite, *Tetranychus flavus* Ewing. Monoethanolamine dinitro-o-cyclohexylphenolate, commonly called mono-DNP by British Columbia growers, may cause some foliage injury. Although it seems to be a selective acaricide, largely innocuous to parasites and insect predators, it can no longer be used generally because most of the spraying is done by automatic concentrate sprayers and these machines increase phytotoxic effects. A second weakness of mono-DNP is its relatively weak acaricidal effect in cool weather. Hence it cannot be used in the "pink"[3] application, which, in British Columbia, is the most favoured spray against the European red mite, *Metatetranychus ulmi* (Koch). Furthermore, mono-DNP is sometimes injurious to the tender young foliage of the early part of the season even when applied by conventional spray gun.

During the season of 1950, field experiments were undertaken with promising new acaricides against the most troublesome orchard mites in the Okanagan Valley of British Columbia. The new acaricides and their performance in the orchard are discussed herewith.

Acaricides under Trial[4]

C-1006 (50 per cent p-chlorophenyl p-chlorobenzene sulphonate; Dow Chemical Co.).—This compound has a low human toxicity rating but a high phytotoxicity rating. Applied to apples in the pink stage at a concentration of 1.5 pounds[5], it caused severe foliage injury to McIntosh, Delicious, Newtown and Winesap. When applied in August at 1 pound it injured Newtown but not Delicious and Winesap.

EPN 300 (27 per cent ethyl p-nitrophenyl thionobenzene phosphonate; E. I. DuPont Co.).—Although EPN 300 has a lower human toxicity rating than parathion, it is, nevertheless, very poisonous. When applied to apple in the pink stage at 0.75 pounds, it injured foliage of McIntosh but not of Delicious, Newtown or Winesap.

KARATHANE (25 per cent dinitro capryl phenyl crotonate; Rohm and Haas Co.).—As a pink application to apple at 1.5 pounds, this dinitro compound has not caused foliage injury to Delicious, McIntosh, Winesap, Jonathan or Newtown, but applied to Newtown in August at the same concentration it caused a slight amount of foliage injury.

R-242 (50 per cent p-chlorophenyl phenyl sulphone; Stauffer Chemical Co.). — This compound has a low human toxicity rating and as a pink or summer application to apple, at 2 pounds, has not caused injury to Delicious, McIntosh, Newtown, Winesap or Jonathan.

ARAMITE (15 per cent beta-chloroethyl beta-(p-tertiary butylphenoxy) alpha methyl ethyl sulphite; Naugatuck Chemicals).—Aramite is rated low in toxicity to humans; and as a pink or summer application, at 2 pounds, has not injured Delicious, McIntosh, Newtown, Winesap or Jonathan.

Effects of Acaricides on Orchard Mites

European Red Mite, *Metatetranychus ulmi* (Koch).—Since the introduction of DDT, this mite has been one of the

1 Contribution No. 2746, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

2 Technical Officer.

3 The term pink is used to denote that period of development when the floral buds have just separated in the cluster and before the first flower has opened.

4 All acaricides were used in the wettable powder form.

5 All concentrations are for 100 imperial gallons (approximately 120 U.S. gallons).

most troublesome orchard pests in the Okanagan Valley. Experimental work carried out by officers of the Summerland laboratory has shown that parathion applied at the pink stage of apple development is highly effective against the red mite. In 1950, several of the newer acaricides were applied at that stage for comparison with parathion. No further acaricide applications were made until the first week in September, when acaricides had to be applied for the control of the two-spotted spider mite. Mite populations were sampled two weeks, one month, and two months after spraying. The results from three orchards are averaged and summarized in Table I.

TABLE I

Effects of pink application of acaricides on the European red mite; materials applied by a conventional hand-gun sprayer.

Acaricide	Amount per 100 gal.	Average number of mites per leaf during season
C-1006 (50%)	1.5 lb.	0.17
Parathion (15%)	1.0 lb.	0.34
EPN 300 (27%)	0.75 lb.	0.40
R-242 (50%)	1.5 lb.	0.44
Karathane (25%)	1.5 lb.	1.88
Check—no treatment		6.74

Two-Spotted Spider Mite, *Tetranychus bimaculatus* Harvey; and Pacific Mite, *Tetranychus pacificus* McG.—These mites are considered together because they generally coexisted in 1950 and occurred together in the trial plots.

The two-spotted spider mite was not a major pest of Okanagan Valley orchards until August, 1950, when it became most troublesome and widespread. The Pacific mite was also more abundant than for several years past. In fact, as pests these two mites replaced the European red mite in importance.

An experiment was carried out to compare several new acaricides with parathion for control of these two species of mites on Delicious, Newtown, Winesap, Jonathan and Yellow Transparent apple trees. The results are summarized in Table II.

TABLE II

Effects of acaricides on the two-spotted spider mite and the Pacific mite; materials applied by a conventional hand-gun sprayer in August, 1950.

Acaricide	Amount per 100 gal.	Average mites per leaf		
		Before spraying	After spraying	
		Aug. 29	Sept. 8	Sept. 13
Aramite (15%)	2 lb.	13.7	0.2	0.4
Parathion (15%)	1 lb.	22.3	0.3	0.6
C-1006 (50%)	1 lb.	39.4	1.8	0.5
R-242 (50%)	2 lb.	30.3	2.3	2.9
Karathane (25%)	1.5 lb.	46.4	3.4	3.3
Check—no treatment		8.0	13.4	18.5

Willamette Mite, *Tetranychus flavus* Ewing.—This pest, first reported in the Okanagan Valley in September, 1949, at Summerland, has been found since then at Oliver, Penticton, and Kelowna.

Early in 1950, before the mite had an opportunity to do a great deal of damage, a few materials, some of which were available to the grower, were applied to single limbs of Delicious apple trees in a preliminary experiment. Before and after the materials had been applied, 10 leaves were picked at random from each of the treated limbs. The leaves were examined for mites under a microscope. Results are summarized in Table III.

TABLE III

Effects of acaricides on the Willamette mite: materials applied by a conventional hand-gun sprayer in July, 1950.

Material	Amount per 100 gal.	Average number mites per leaf Before spraying July 5	After spraying July 10
Parathion (15%)	1 lb.	2.3	0
Dinitro-o-cyclohexyl phenol (40%)	5 oz.		
Parathion (15%)	1 lb.	5.3	0
Stove oil[6]	1 qt.		
Parathion (15%)	2 lb.	14.9	0.2
Dinitro-o-cyclohexyl phenol (40%)[7]	5 oz.	9.2	0.2
EPN 300 (27%)	1.5 lb.	19.1	0.5
Check—Water		5.4	10.1

6 34 S.S.U. Vis. 100°F., over 75% U.R.

7 DN-Dry Mix No. 1. Dow Chemical Co., Toronto, Ont.

As an outcome of this experiment, a mixture of 15 per cent parathion, 8 pounds per acre, and 40 per cent dinitro-o-cyclohexylphenol, 2 pounds per acre, was applied to Delicious apple trees by an automatic concentrate sprayer. Excellent control was achieved; the Willamette mite remained at a very low level for seven weeks. Spray injury was confined to sucker growth. In another orchard heavily infested with the Willamette mite, two parathion-dinitro mixtures were applied with an automatic concentrate sprayer. In one plot parathion was maintained at 8 pounds per acre and in a second plot it was reduced to 3 pounds per acre. There was little difference in degree of control between the two plots.

In another experiment three of the new acaricides were compared with parathion alone. Four trees were sampled in each plot of 15 to 20 trees. Samples from each tree consisted of 100 leaves, and an estimation of effectiveness was made from the number of infested leaves. The toxicants were applied with an automatic concentrate sprayer in August, 1950. Results are summarized in Table IV.

TABLE IV

Effects of acaricides on the Willamette mite: materials applied by an automatic concentrate sprayer in August, 1950.

Acarcide	Amount per acre	Percentage infested leaves Before spraying Aug. 24	After spraying Aug. 31	Sept. 1
Aramite (15%)	12 lb.	84.2	1.7	0
Karathane (25%)	12 lb.	97.5	0.5	0.2
R-242 (50%)	12 lb.	99.2	39.0	41.7
Parathion (15%)	8 lb.	90.5	60.2	61.5
Check—no treatment		99.2	96.2	97.0

Summary

(1) During 1950, five new, promising acaricides were compared with parathion for control of various mites in orchards of British Columbia. These were:

C-1006 (50 per cent p-chlorophenyl p-chlorobenzene sulphonate).

EPN 300 (27 per cent ethyl p-nitrophenyl thionobenzene phosphonate).

KARATHANE (25 per cent dinitro capryl phenyl crotonate).

R-242 (50 per cent p-chlorophenyl phenyl sulphone).

ARAMITE (15 per cent beta-chloroethyl beta-(p-tertiary butyl phenoxy) alpha methyl ethyl sulphite).

(2) C-1006 has a low human toxicity rating but a rather high phytotoxicity rating. At 1.5 pounds per 100 gallons, it was the most effective acaricide used in the pink application for control of the European red mite. When used as a summer spray at 1 pound, it

gave excellent control of the two-spotted spider mite and the Pacific mite.

(3) EPN 300 has a high human toxicity rating and a medium phytotoxicity rating. When applied in the pink stage at 0.75 pounds it gave good control of the European red mite although it was somewhat inferior to 1 pound of parathion. At 1.5 pounds it gave considerably better control of the Willamette mite than 1 pound of parathion.

(4) KARATHANE applied at the rate of 1.5 pounds was not so effective as 1 pound of 15 per cent parathion when used as a pink application for control of the European red mite, or when used in summer applications for control of the two-spotted spider mite and the Pacific mite. When applied in the summer by an automatic sprayer at 12 pounds per acre, however, it gave excellent control of the Willamette mite. Although it caused a very slight amount of damage to Newtown apple trees in August, it has a low phytotoxicity rating.

(5) R-242 has a low human toxicity rating and a low phytotoxicity rating. At 1.5 pounds, it was slightly less effective than 1 pound of parathion (15 per cent) when used as a pink application for control of the European red mite. When used in the summer at 2 pounds it was not so effective as 1 pound of parathion for control of the two-spotted spider mite and the Pacific mite. When used at 12 pounds per acre in a concentrate sprayer, however, it was slightly more effective against the Willamette mite than 8 pounds of parathion.

(6) ARAMITE has a low human toxicity rating and low phytotoxicity rating. When applied in the summer at 2 pounds, it gave excellent control of the two-spotted spider mite and the Pacific mite. Also, when applied by a concentrate sprayer at 12 pounds per acre, it gave excellent control of the Willamette mite.

NOTES ON THE SPRING ACTIVITY OF THE ROCKY MOUNTAIN WOOD TICK, DERMACENTOR ANDERSONI STILES (ACARINI: IXODIAE)[1]

J. D. GREGSON

Livestock Insect Laboratory, Kamloops, B. C.

One of the remarkable features in the life-cycle of the Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, in British Columbia is the annual appearance of adults at the beginning of spring and their regular disappearance about the middle of May. Such seasonal periodicity is natural for most insects, of which the adult stage is generally of short duration. However, ticks usually live longer than insects, and it would be expected that adults of the Rocky Mountain wood tick, which are herewith shown to be capable of living for at least 1 year, which continue to be active as long as the weather remained favourable. Such is not the case, however, and though in Alberta and in the damper regions of British Columbia adults of this species may be active as late as June, in the British Columbia dry-belt they disappear regularly in May, regardless of how moist or cool the prevailing atmospheric conditions are. It is suggested that some form of diapause must take effect, releasing its hold only after another winter has passed.

In the Interior of British Columbia the Rocky Mountain wood tick is distributed throughout the greater part of the dry bunch-grass open-land. Its peak abundance may vary, depending on the locality, from sparse populations to heavy concentrations. The latter occur in scattered parts of the Province where host and climatic conditions are apparently particularly ideal for tick development and survival. One such site is at Rayleigh, 10 miles north of Kamloops, B. C., where there is an extensive talus slope backed by a rocky bluff 200 feet high. The narrow belt of vegetation at the base of the cliff, besides harbouring a variety of rodent life, seems regu-

1 Contribution No. 2717, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

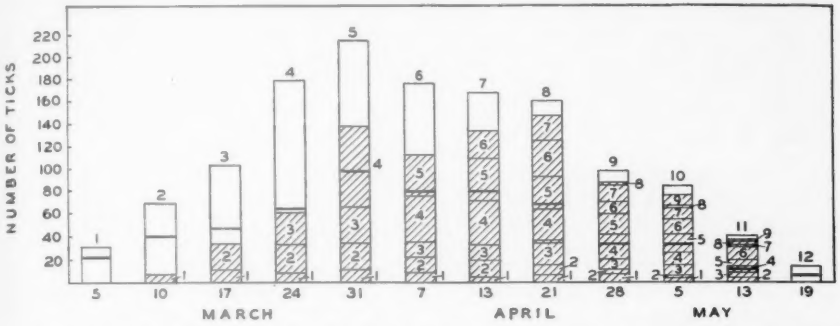

Fig. 1. Weekly collections of the Rocky Mountain wood tick, **Dermacentor andersoni** Stiles, at Rayleigh, B. C., during the spring of 1949. The hatched portions represent the numbers of marked ticks recaptured, the numerals indicating those of the various weeks. The dark horizontal lines indicate the numbers of males.

larly to have a copious supply of adults of *andersoni*, despite large annual collections for laboratory use. For the past 6 years their earliest appearance has been recorded on the following dates: 1945, Feb. 24; 1946, Feb. 26; 1947, Feb. 19; 1948, Mar. 17; 1949, Feb. 25; 1950, Feb. 27.

During 1949 and 1950 an attempt was made to show their rise, peak and decline of activity by counting and releasing all specimens as soon as they were collected on the drag, i.e., a square yard of flannelette that is swept over the vegetation in the manner of a flag. In addition, to determine whether the earliest ticks would be the first to disappear, each week's collections in 1949 were marked with a different colour of Fleet-X automobile enamel, a slow-drying Duco-like paint. The results of these observations are illustrated in Fig. 1, in which the number of marked ticks for each week is indicated. The activity of the ticks is shown to be equally late, regardless of when they appeared.

It must be noted that the data for the weekly periods of activity cannot be entirely accurate, for only a fraction of each week's marked specimens was recaptured. The recoverable portion appeared to be rather constant and in the neighbourhood of 40 per cent. Accordingly it is reasonable to assume that some 60 per cent of each week's active ticks, both old and new, are not recovered, and that the following week's unmarked specimens have not all recently hatched or emerged from hibernation. This incomplete recovery is explained by the fact that the ticks do not constantly present themselves in favourable positions for transference to a host or may have already attached themselves to hosts. Casual observations during sunny days have revealed that they very actively run about on the ground, and climb up twigs, only to descend again. Such individuals would not be readily available for capture on the drag and would account for the fact that often when one sits for a few minutes he or his drag picks up several specimens not otherwise detectable. This activity, which is contrary to the impression gained from the usual appearance of ticks waiting motionless at the tops of grass stems, leads to a certain amount of dispersal, and marked specimens were recovered nearly 20 feet from their point of liberation 2 weeks previously. Other individuals showed no tendency to roam, and week after week were observed at the same clump of grass.

Collections of ticks in the same area the following spring (Fig. 2) have shown nearly 8 per cent of the previous season's marked ticks still active, this figure being the percentage for the greatest number (40) of marked ticks taken at one time (April 17, 1950) of the total number (530) of ticks marked in the previous year. Since no attempt was made to re-mark the 1950 captures, it is not known how many others were collected on other days and it is likely that this percentage is even higher. The

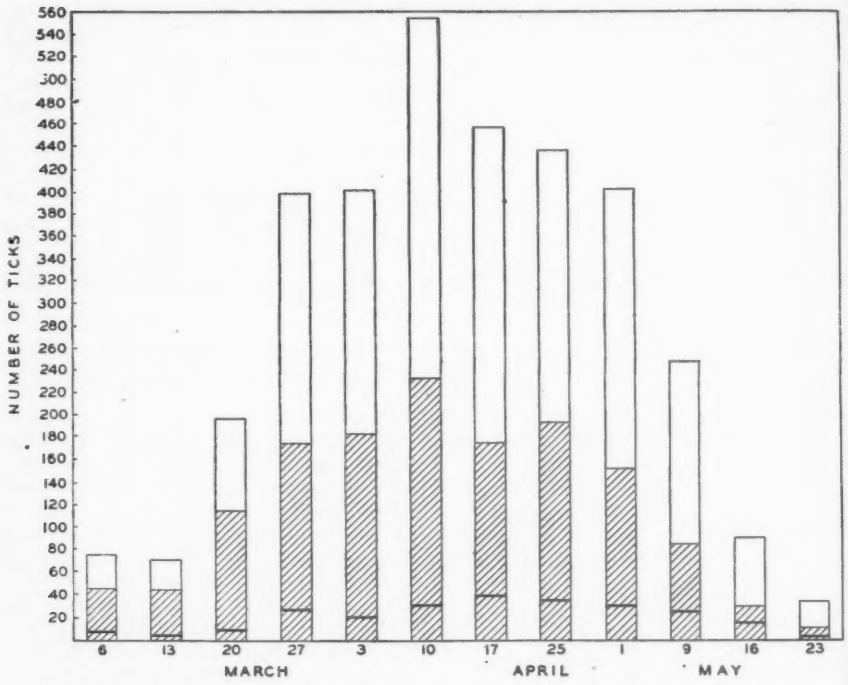

Fig 2. Weekly collections of the Rocky Mountain wood tick at Rayleigh, B. C., during the spring of 1950. The dark horizontal lines indicate the numbers of 1949 marked ticks recaptured. The hatched areas represent the numbers of males.

year-old ticks were virile enough to persist to the end of the tick season. That the remaining 1950 adults were new stock moulted from nymphs that had fed during the previous summer is suggested by the early appearance of the males, a phenomenon common in the first appearance of various species of insects.

The nearly equal ratio of the sexes and the earlier appearance and disappearance of the males are shown in Figs. 1 and 2. The peak of tick activity fell approximately at the end of March in 1949 and on April 10 in 1950. This is in keeping with the relative earliness of the two seasons, the spring of 1950, as indicated by phenological observations, being approximately a week later than that of 1949. The main period of tick activity lasted from the height of the flower season of the common dry-belt buttercup, *Ranunculus glaberrimus* and of the johnny-jump-up, *Fritillaria pudica*, to the appearance of blossoms of saskatoon, *Amelanchier* sp. and of Oregon-grape, *Mahonia nervosa*. Activity ceased with the blooming of the chokecherry, *Prunus demissa*. The reason for the apparent great increase in the tick population at Rayleigh in 1950 is unexplained.

What causes the ticks to disappear toward the middle of May is not known. A study of the temperature and humidity fluctuations recorded during their activity reveals no striking change that could account for their sudden decline. Disappearance due to a gradual aging or depletion of energy is ruled out by their reappearance the following year without having had a meal in the interim.

Observations were made to determine the fate of these ticks after activity. A number of adults were enclosed in a cage over talus 3 feet deep from the time they became active in 1949 until the following spring. All that were recovered (15 per cent) were found dead in

the upper inch of leaf mould, suggesting that the ticks do not seek protection from winter by descending to any depth in loose rock. Because of the presence of the cage, the ground surface was not protected by snow, with the result that it was exposed to a temperature of –40° F. However, temperature readings taken at a depth of 1 foot in the talus beneath the cage did not go below 32° F. The only adult found in its apparently natural site of hibernation was an unengorged female, located by accident in November under a small rock at ground level. Careful search during summer months in the areas where concentrations of ticks had been liberated the previous spring has, however, revealed specimens among the decaying roots of bunch grass, *Agropyron* sp., substantiating the theory that adult aestivation and hibernation are spent at shallow levels.

In conclusion, it has been shown that a portion of these ticks are capable of living more than 12 months as unfed adults, passing the winter under the protection of snow. The disappearance of all the ticks in late spring is apparently due not to normal aging but to some form of diapause, the cause of which is not known.

RECORDS OF BEES FROM BRITISH COLUMBIA: BOMBIDAE[1]

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This paper records 26 species, 14 named varieties, and 10 colour variants of *Bombus* and 4 species of *Psithyrus* from British Columbia. Of the 5326 specimens here recorded, 4641 belong to *Bombus*, and 685 to *Psithyrus*.

These records have been compiled from the collections in the Dominion Entomological Laboratory, Kamloops, B. C.; the University of British Columbia, Vancouver, B. C.; and the Provincial Museum, Victoria, B. C.; and from the Canadian National Collection, Ottawa, Canada, as well as from some records in publications by Franklin and Frison, and some unpublished notes by Frison. Almost all of the records obtained from the Canadian National Collection were from specimens determined by Frison.

These bumble bees were collected by 97 collectors during 50 years from 142 localities; except F. W. L. Sladen, E. R. Buckell, and G. J. Spencer, they paid little attention to taxonomy of bees, and their material was obtained in the course of general collecting. The localities are listed and their corresponding numbers placed on the accompanying map.

The collection points are mainly in the southern half of the Province, and vast areas in the north have not yet been visited by collectors. This, of course, is due to the fact that there are no roads, railways, or other ready means of entering these areas.

There are no collection records from the Queen Charlotte Islands, but several species must occur there as they have been taken on the adjacent mainland and on islands off the Alaskan coast.

After the name of each species the number of localities in which it has been taken, the number of each sex, and the total number of specimens recorded are indicated, e.g.: (26: 80♂ 39♀ 83♀—202).

The author wishes to thank all those who have helped in the preparation of this paper, either by the loan of material or in providing species determination or locality records. Thanks are particularly due to Mr. K. V. Krombein, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, Washington, D. C., for the determination of material, and to Dr. O. Peck, Division of Entomology, Department of Agriculture, Ottawa, Canada, for the British Columbia records in the Canadian National Collection.

1 Contribution No. 2734, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

2 Retired November 1, 1949.

TABLE I

Localities from which Bombidae have been recorded in British Columbia. The numbers correspond to those on the accompanying map. (V. I.=Vancouver Island.)

1. Adams Lake
2. Agassiz
3. Alberni, V. I.
4. Alexis Creek
5. Armstrong
6. Arras
7. Ashcroft
8. Aspen Grove
9. Atlin
10. Barkerville
11. Bella Coola
12. Boston Bar
13. Boswell
14. Bridge Lake
15. Buccaneer Bay
16. Burns Lake
17. Canim Lake
18. Carbonate
19. Cedarvale
20. Celista
21. Centurian
22. Chapmans
23. Chase
24. Chilcotin
25. Chopaka
26. Clinton
27. Comox, V. I.
28. Copper Mountain
29. Courtenay, V. I.
30. Cowichan, V. I.
31. Cranbrook
32. Crescent
33. Creston
34. Crows Nest
35. Departure Bay, V. I.
36. Duncan, V. I.
37. East Pine
38. Fairview
39. Fernie
40. Field
41. Fitzgerald, V. I.
42. Forbidden Plateau, V. I.
43. Fort Steele
44. Fraser Lake
45. Glacier
46. Golden
47. Goldstream, V. I.
48. Hat Creek
49. Hazelton
50. Hedley
51. Hope
52. Hope Mountain
53. Hudson Hope
54. 100 Mile House
55. Invermere
56. Inverness
57. Jesmond
58. Jordan Meadows, V. I
59. Kaleden
60. Kamloops
61. Kaslo
62. Kelowna
63. Keremeos
64. Kitchener
65. Kitwanga
66. Ladysmith, V. I.
67. Langley
68. Lardo
69. Lillooet
70. Lumby
71. Lytton
72. Macalister
73. Manning Park
74. Merritt
75. Metlakatla
76. Midday Valley
77. Milner
78. Minnie Lake
79. Mission
80. Mount Arrowsmith, V. I.
81. Mount Cheam
82. Mount McLean
83. Nanaimo, V. I.
84. Nelson
85. Newcastle Is.
86. Newgate
87. New Westminster
88. Nicola
89. Okanagan Falls
90. Okanagan Mission
91. Oliver
92. Osoyoos
93. Oyama
94. Pacific
95. Peachland
96. Pender Harbour
97. Penticton
98. Pouce Coupe
99. Powell River
100. Premier Lake
101. Prince George
102. Prince Rupert
103. Quesnel
104. Quick
105. Radium
106. Revelstoke
107. Rogers Pass
108. Rolla
109. Royal Oak, V. I.
110. Saanich, V. I.
111. Sahtlam, V. I.
112. Shawnigan, V. I.
113. Salmon Arm
114. Salvus
115. Savona
116. Shuswap
117. Sicamous
118. Sidney, V. I.
119. Smithers
120. Soda Creek
121. Sooke, V. I.
122. Stanley
123. Stikine
124. Sugar Lake
125. Summerland
126. Terrace
127. Tofino, V. I.
128. Trinity Valley
129. Tyee
130. Ucluelet, V. I.
131. Vancouver
132. Vanderhoof
133. Vaseaux Lake
134. Vernon
135. Victoria, V. I.
136. Walhachin
137. Wellington, V. I.
138. Westbank
139. Westholme, V. I.
140. White Lake
141. Williams Lake
142. Yale

The Province of British Columbia, 355,855 square miles in area, is approximately the same size as the Pacific States of Washington, Oregon, and California. It is a land of mountains, valleys, and lakes, with a wide altitudinal range and extending over 11 degrees of latitude.

These topographical features have a marked influence on climatic conditions, and the vegetation varies from the humid luxuriance of the southern coastal region to the semi-arid, cactus, and sagebrush areas of the interior plateau. The close succession of markedly different geographical features has produced a wide variety of plant and animal associations, and many species of insects, including the bumble bee, are often confined to widely scattered but similar habitats.

MAIN GEOGRAPHICAL AREAS

For the purposes of this paper, the following are the main geographical areas of British Columbia, with a brief description of ecological conditions in each.

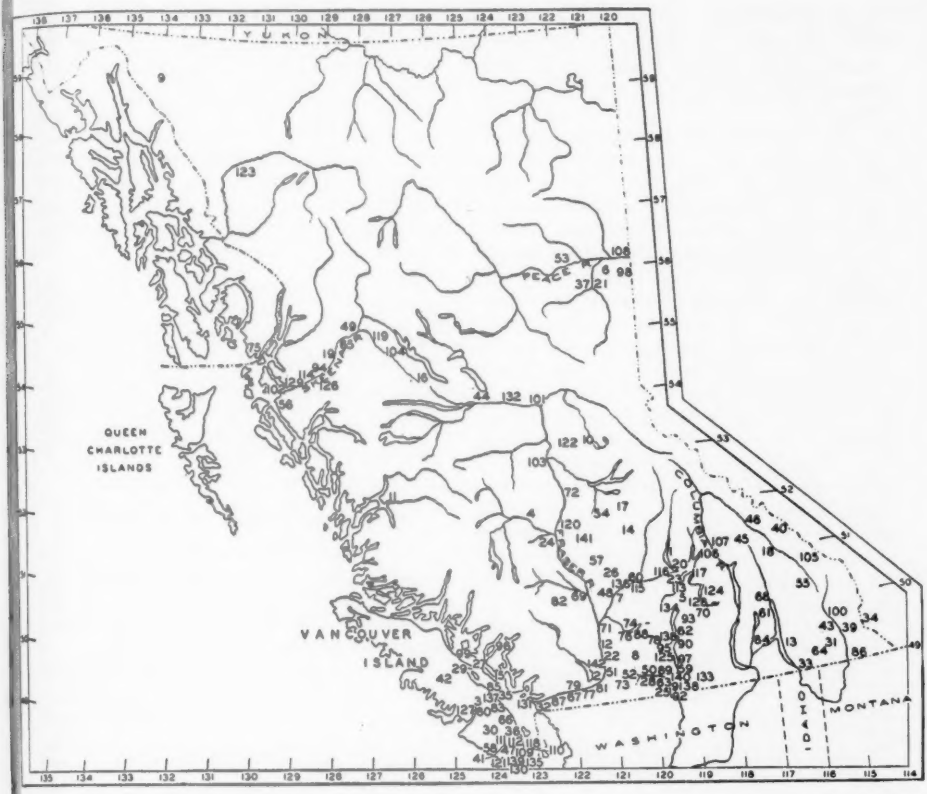

Fig. 1. Map of British Columbia showing the 142 localities mentioned in the text.

Southeastern British Columbia (Area No. 1)

This is a comparatively small, triangular region, of particular interest in that both the flora and fauna sometimes bear a closer relationship to those of Alberta and northwestern United States than to the remainder of the Province. Insects can enter this region from Alberta with little difficulty, through the low, dry Crows Nest Pass; from Montana and Idaho through the valley of the Kootenay River; and from northeastern Washington up the valley of the Columbia River.

This region is bounded on the east by the British Columbia-Alberta boundary, which is the summit of the main range of the Rocky Mountains; on the west by the almost impenetrable mass of high, snow-capped, heavily timbered Selkirk Mountains; and on the south by the International Boundary between British Columbia and the northwestern states of Montana, Idaho, and Washington, which, of course, presents no physical barrier.

The following localities are included in this area: Carbonate, 18; Radium, 105; Invermere, 55; Premier Lake, 100; Fort Steele, 43; Crows Nest, 34; Fernie, 39; Cranbrook, 31; Newgate, 86; Kitchener, 64; Creston, 33; Boswell, 13; Kaslo, 61; Lardo, 68; Nelson, 84.

Southern Interior (Area No. 2)

For the purpose of this paper the southern interior extends from the International Boundary, bordering the

State of Washington, north to latitude 52°, and from the western boundary of southeastern British Columbia west to the eastern slopes of the Coast Mountains.

The eastern and western boundaries are excellent natural geographical barriers. The southern boundary presents more of a barrier to insects than is indicated by a glance at the map, for the eastern and western mountain masses form a definite bottleneck, through which the Okanagan and Similkameen rivers flow south in narrow, hot valleys.

Latitude 52° has been chosen as the boundary line between the southern and central interior regions. There are no very definite geographical barriers along latitude 52°, but the collection records of a number of species definitely show that at about this latitude there is a marked distributional change, probably because the mountainous terrain of the southern interior gives way at this point to an undulating plateau, from 2500 to 4000 feet in elevation.

The following localities are included in this area: Osoyoos, 92; Oliver, 91; Fairview, 38; White Lake, 140; Vaseaux Lake, 133; Okanagan Falls, 89; Kaleden, 59; Penticton, 97; Keremeos, 63; Chopaka, 25; Hedley, 50; Copper Mountain, 28; Summerland, 125; Peachland, 95; Westbank, 138; Kelowna, 62; Okanagan Mission, 90; Oyama, 93; Vernon, 134; Lumby, 70; Trinity Valley, 128; Sugar Lake, 124; Armstrong, 5; Field, 40; Golden, 46; Glacier, 45; Rogers Pass, 107; Revelstoke, 106; Sicamous, 117; Salmon Arm, 113; Celista, 20; Adams Lake, 1; Chase, 23; Shuswap, 116; Kamloops, 60; Merritt, 74; Midday Valley, 76; Nicola, 88; Minnie Lake, 78; Aspen Grove, 8; Savona, 115; Walhachin, 136; Ashcroft, 7; Hat Creek, 48; Lytton, 71; Lillooet, 69; Mt. McLean, 82; Clinton, 26; Jesmond, 57; Bridge Lake, 14; Canim Lake, 17; 100 Mile House, 54; Williams Lake, 141; Soda Creek, 120; Chilcotin, 24; Alexis Creek, 4.

Central Interior (Area No. 3)

This region extends north from latitude 52° to latitude 55° 30′, and from the Alberta boundary and the Rocky Mountains on the east to the Coast Mountains on the west. As in the southern interior region, the eastern and western boundaries are natural geographical barriers of high, unbroken mountain chains. The northern boundary presents no geographical features to limit the distribution of insects. It has been chosen only because it encloses the northernmost records found in the central interior region.

The following localities are included in this area: Macalister, 72; Quesnel, 103; Stanley, 122; Barkerville, 10; Prince George, 101; Vanderhoof, 132; Fraser Lake, 44; Burns Lake, 16; Quick, 104; Smithers, 119; Hazelton, 49; Kitwanga, 65; Cedarvale, 19; Pacific, 94; Terrace, 126; Salvus, 114; Tyee, 129.

Northern Interior (Area No. 7)

This region extends north from latitude 55° 30′ to the Yukon boundary, latitude 60°, and from the Rocky Mountains on the east to the Coast Mountains (boundary of Alaskan panhandle) on the west. As in the southern and central interior regions, the mountains of the eastern and western boundaries are natural geographical barriers. The boundaries on the north and south present no obstacles to insect distribution.

This region is entirely without roads or railways and the only collection records are from Stikine, 123, and Atlin, 9, both in the extreme northwestern corner of British Columbia.

Northeastern British Columbia (Area No. 6)

This triangular area lies entirely to the east of the Rocky Mountains and is geographically part of the northwestern parkland area of Alberta. It is bounded on the west by the Rocky Mountains, which constitute its only natural geographical boundary. To the north, the Yukon boundary and to the east, the Alberta boundary present no hindrance to the spread of insects.

Collections have been made only in the southern tip of this region, close to the Peace River, and include the follow-

ing localities: Rolla, 108; Pouce Coupe, 98; Arras, 6; Centurian, 21; East Pine, 37; Hudson Hope, 53.

Mainland Coast (Area No. 4)

This region consists of precipitous mountains descending to the sea, and innumerable inlets and small islands. The only extensive area of agricultural land is situated in the extreme south, in the delta of the Fraser River; there is a much smaller area in the extreme north, at the mouth of the Skeena River. This region is sharply separated from the interior of the Province by the high, rugged Coast Mountains, the northern boundary being the southern tip of the Alaskan panhandle, and the southern boundary the British Columbia-Washington line, south of the Fraser River.

The following localities are included in this area: Boston Bar, 12; Chapmans, 22; Yale, 142; Hope, 51; Hope Mountains, 52; Agassiz, 2; Mt. Cheam, 81; Milner, 77; Langley, 67; Mission, 79; Crescent, 32; New Westminster, 87; Vancouver, 131; Buccaneer Bay, 15; Pender Harbour, 96; Powell River, 99; Newcastle I., 85; Inverness, 56; Prince Rupert, 102; Metlakatla, 75.

Vancouver Island (Area No. 5)

Bumble bees have been collected extensively on Vancouver Island. The records are from the southern end of the Island and for some distance up the east coast. The west coast and the northern half of the Island are areas of very heavy rainfall and dense coniferous forests, and what small settlements there are consist mainly of coastal logging camps.

The following localities are included in this area: Victoria, 135; Westholme, 139; Ucluelet, 130; Sooke, 121; Goldstream, 47; Royal Oak, 109; Saanich, 110; Sidney, 118; Fitzgerald, 41; Shawnigan, 112; Duncan, 36; Jordan Meadows, 58; Sahtlam, 111; Cowichan, 30; Ladysmith, 66; Nanaimo, 83; Departure Bay, 35; Wellington, 137; Alberni, 3; Tofino, 127; Mt. Arrowsmith, 80; Comox, 27; Courtenay, 29; Forbidden Plateau, 42.

Table II gives the distribution and the altitude range of Bombidae in British Columbia; the species, which include the varieties and colour variants, are listed in order of abundance, *Psithyrus* spp. being listed separately from *Bombus* spp. In determining this order the number of localities in which a species had been taken (column 2) was given preference over the number of specimens recorded (column 3), as the writer believes this gives a much more reliable indication of the status of the species. The altitude range is the range in which the species is most commonly found and not necessarily its extreme limits. Further extensive collecting would undoubtedly result in some changes, but for the data on hand the table gives a very fair indication of the general prevalence, distribution, and altitude range of the species in the Province.

TABLE II

Distribution and altitude range of Bombidae in British Columbia.

Genera and species in order of abundance in collections	Localities	Total Specimens	Distribution by areas* in order of abundance in collections	Approximate altitude range: feet
Bombus				
bifarius	83	677	2, 1, 3, (4, 5), *7, 6	0-7000
occidentalis	77	430	(1, 2, 3), (4, 5), 7, 6	0-7000
flavifrons	74	400	(2, 3, 5), 4, 1, 7	0-7000
mixtus	64	445	(1, 2, 3, 4, 5), 7, 6	0-6000
melanopygus	56	353	(4, 5), (1, 2), 3, 6, 7	0-6000
vagans	49	398	(2, 3), 1, 7, 6, 4, 5	1000-4000
californicus	49	237	(2, 3, 4, 5), 1, 6	0-2000
sitkensis	42	344	(4, 5), (1, 2, 3)	0-6000
appositus	34	182	2, 1, 4	1000-2000
centralis	26	202	2, 1	1000-2000
terricola	23	191	3, 2, 6, 7, 4	2000-3000
nevadensis	21	71	2 north, 5, (1, 3), 6	0-2000
rufocinctus	20	98	2, 1, 5	2000-3000
fervidus	17	122	2	1000-2000
ternarius	11	243	3, 1, 2	1000-3000
sylvicola	7	153	2, 3, 1, 4	2000-7000
griseocollis	7	28	2 south	1000
morrisoni	7	12	2	1000-2000
frigidus	7	5	(1, 2), 5	1000-2000
perplexus	6	7	3, 4	0-2500
huntii	4	3	1	1000-3000
hirbyellus	2	29	3, 2 north	6000-9000
hyperboreus	2	3	2 north	3500-8000
auricomus	2	2	(5, 6)	0-1000
vosnesenskii	1	3	2	1000
pleuralis	1	3	2	1000
Total 26		—4641		
Psithyrus				
insularus	57	262	(1, 2, 3, 4, 5), 6, 7	0-5000
suckleyi	51	253	(1, 2, 3, 4, 5)	0-5000
fernaldae	21	80	(1, 2, 3, 4, 5, 7)	3000-7000
ashtoni	10	90	3, 2 north	3000-5000
Total 4		— 685		
Grand Total 30	142	5326		0-9000

* Brackets enclose the numbers for areas in which the species is equally abundant. See text.

Genus BOMBUS Latreille

Section *Boopobombus* Frison

Subgenus **Fraternobombus** Skorikov

No species of this subgenus have as yet been recorded from British Columbia.

Subgenus **Nevardensibombus** Skorikov

Bombus nevadensis Cresson (21: 1♂ 54♀ 16☿—71)

LOCALITIES—Invermere, Kaslo, Vernon, Trinity Valley, Salmon Arm, Chase, Kamloops, Nicola, Minnie Lake, Walhachin, Williams Lake, Chilcotin, Macalister, Quesnel, Rolla, Victoria, V. I., Sooke, V. I., Royal Oak, V. I., Sidney, V. I., Fitzgerald, V. I., Departure Bay, V. I.

The 71 specimens of *nevadensis* recorded from 21 localities indicate that it is a fairly common bumble bee in British Columbia, and that it is widely dispersed in areas of temperate climate. It has been taken frequently on Vancouver Island and throughout the timbered regions of the interior, from the southeastern corner of the Province to the Peace River at latitude 56°, but not in the dry, hot sagebrush areas of the Okanagan Valley or in high mountain localities.

Bombus auricomus Robertson (2: 0♂ 2♀ 0☿—2)

LOCALITIES—Centurian, Aug. 4, 1921, 1♀. Departure Bay, V. I., May 24, 1925, 1♀.

This is apparently a rare species in British Columbia, and little is as yet known of its distribution. Centurian

is in the Peace River district north of latitude 56°, and Departure Bay on the southeast coast of Vancouver Island.

Subgenus **Separatobombus** Frison

Bombus griseocollis (DeGeer) (6: 1♂ 11♀ 6☿—18)

[=B. *separatus* Cresson]

LOCALITIES — Osoyoos, Oliver, Fairview, Vaseaux Lake, Okanagan Falls, Penticton.

Bombus griseocollis var. **mormonorum** Franklin (5: 3♂ 4♀ 3☿—10)

LOCALITIES — Osoyoos, Fairview, Okanagan Falls, Penticton, Vernon.

B. griseocollis and its variety *mormonorum* have been taken only in the Okanagan Valley, and, with the exception of the worker from Vernon, all were collected in the Upper Sonoran Zone, which extends up the Okanagan Valley as far as Penticton. It is probable that this species occurs also in the Similkameen River Valley from the Washington border to Keremeos. It has a wide range in the United States, and Scullen (1927) records it from Alaska.

Bombus morrisoni Cresson (7: 1♂ 4♀ 7☿—12)

LOCALITIES—White Lake, Kamloops, Nicola, Walhachin, Ashcroft, Lillooet, Chilcotin.

B. morrisoni is one of the rarer species in British Columbia and has been taken only in hot, dry locations in the southern interior and at Chilcotin, where an extension of sagebrush dry-belt conditions extends up the valley of the Chilcotin River.

This bumble bee could easily be confused with *B. nevadensis* or *B. griseocollis* var. *mormonorum* in the field, as they are very similar in coloration. It is a large and handsome species with dense yellow pile covering the entire dorsum of the thorax, and the dorsum of the abdomen to the basal centre of segment four; the apex of the abdomen is black.

Subgenus **Cullumanobombus** Vogt

Bombus rufocinctus Cresson (10: 17♂ 6♀ 28☿—51)

LOCALITIES—Fernie, Kaslo, Kaleden, Okanagan Mission, Vernon, Lumby, Kamloops, Walhachin, Hat Creek, Chilcotin.

Bombus rufocinctus var. **albertensis** Cockerell (5: 0♂ 4♀ 7☿—11)

LOCALITIES — Crows Nest, Oliver, Keremeos, Vernon, Chilcotin.

Bombus rufocinctus var. **prunellae** Cockerell & Porter (8: 3♂ 3♀ 6☿—12)

LOCALITIES — Vernon, Armstrong, Revelstoke, Kamloops, Merritt, Chilcotin, Saanich, V. I., Fitzgerald, V. I.

Bombus rufocinctus var. **iridis** Cockerell & Porter (1: unknown)

LOCALITY—Glacier (Frison unpublished notes).

All other bumble bee records from Glacier are by Sladen (17.V.1915), and it is assumed that he was the collector in this instance.

In addition to the three named varieties listed above, the Kamloops collection contains material of other colour variants described by Franklin (1913). These are listed below.

Colour variant 4. (4: 1♀ 8☿—9)

LOCALITIES — Crows Nest, Fernie, Vernon, Kamloops.

Colour variant 5. (1: 1♀ 0☿—1)

LOCALITY—Kaslo, July 30, 1906, 1♀.

Colour variant 6. (3: 0♀ 7☿—7)

LOCALITIES—Crows Nest, Fernie, Chilcotin.

Male colour variant 5. (1: 2♂—2)

LOCALITY—Vernon.

Male colour variant 8. (4: 5♂—5)

LOCALITIES—Kaleden, Summerland, Kamloops, Chilcotin.

B. rufocinctus, with the three varieties (*albertensis*, *prunellae*, and *iridis*) and the five colour variants here recorded, is represented by 98 specimens from 20 localities. They have been collected at widely separated points in the southeastern part of the Province, as well as throughout the southern interior north to Chilcotin, latitude 52°, and there are records of two queens from southern Vancouver Island. There are no records of *rufocinctus* from the central or northern interior or from the northeastern section of the Province. The collection records indicate that its extreme altitude limits are from sea level to 3000 feet, with an optimum altitude range from 2000 to 3000 feet. The varieties and colour variants collected to date appear to indicate no geographical preference, but variety *prunellae* is the only form of *rufocinctus* as yet recorded from Vancouver Island. It is extremely variable in colouration and the majority of specimens on hand show a lack of contrasting colours. In the field it is readily overlooked as a badly faded specimen of some common species, and it may be commoner than the number of records indicates. Further extensive collecting

is needed to determine accurately the distribution and altitude range of *rufocinctus* in British Columbia.

Section *Anodontobombus* Krüger

Subgenus *Alpinobombus* Krüger

Bombus hyperboreus Schnönherr (2: 0♂ 3♀ 0☿—3)

[=B. *arcticus* Kirby]
(See Frison, 1919, p. 456)

LOCALITIES—Mt. McLean, July 12, 1926, 1♀, Chilcotin, July 14, 1921, 1♀; July 12, 1931, 1♀.

This species occurs in the northern regions of Europe and Asia and in Greenland and arctic Canada (Franklin, 1913; Frison, 1919, p. 456). It is indistinguishable from *B. kirbyellus* in the field.

The collection of two queens of *hyperboreus* in 1926 and 1931 by the author at Chilcotin, elevation 3500 feet, is unusual, as one would not expect to find this bee at such a low elevation and in such a warm location. Further search on numerous occasions throughout the Chilcotin area, as well as on high mountains farther north, has not yielded any specimens of this species. The queen taken on Mt. McLean, although considerably farther south, was taken well above timber line, near permanent snow-fields, at an elevation of 7500 feet.

The determinations of the specimens have been confirmed by Dr. Krombein, of the United States National Museum. Further material must be collected before the abundance and distribution of *hyperboreus* in British Columbia can be determined.

Bombus kirbyellus Curtis (2: 6♂ 10♀ 13☿—29)

LOCALITIES—Chilcotin, Aug. 12, 1921, 1♀, Barkerville, June 29, 4♀; July 17, 6♂ 5♀ 13☿, 1948.

The record of *kirbyellus* from Chilcotin by the author was obtained in the same field as that in which *hyperboreus* was collected and is another record which is puzzling, as no further specimens have been found there. These specimens of *kirbyellus* and *hyperboreus* were taken during general collecting before the author became interested in bumble bees. Obtaining these in a general collection would indicate that both of them were fairly common species, but repeated search at Chilcotin has not yielded any more specimens. It was not until 1948 that a small series of *kirbyellus* was obtained on Mount Murray, near Barkerville (lat. 53°), at an elevation of 6500 feet.

B. kirbyellus is said to be a strictly boreal species and has been taken at high elevations as far south as New Mexico. It very probably occurs on mountain tops above 7000 feet, in various parts of British Columbia, but the difficulty in reaching such elevations makes its collection difficult. It does not appear to occur on the summit of Mount Revelstoke, 6500 feet, where the author has frequently made collections. At the latitude of Revelstoke (51°), the elevation of 6500 feet may be too low.

As for *hyperboreus*, further extensive collecting is needed to determine accurately the distribution and altitude range of *kirbyellus* in British Columbia.

Subgenus **Terrestribombus** Vogt

Bombus occidentalis Greene (75: 152♂ 108♀ 132☿—392)

LOCALITIES — Carbonate, Radium, Invermere, Fort Steele, Crows Nest, Fernie, Cranbrook, Newgate, Kitchener, Kaslo, Oliver, Fairview, Okanagan Falls, Kaleden, Penticton, Keremeos, Hedley, Summerland, Kelowna, Okanagan Mission, Vernon, Sugar Lake, Armstrong, Field, Golden, Glacier, Rogers Pass, Revelstoke, Sicamous, Salmon Arm, Chase, Shuswap, Kamloops, Merritt, Nicola, Minnie Lake, Walhachin, Clinton, Chilcotin, Bella Coola, Burns Lake, Smithers, Hazelton, Kitwanga, Cedarvale, Terrace, Salvus, Tyee, Prince Rupert, Lillooet, Mt. McLean, Lytton, Boston Bar, Yale, Hope, Hope Mts., Agassiz, Mt. Cheam, Milner, Vancouver, Buccaneer Bay, Newcastle I., Victoria, V. I., Royal Oak, V. I., Saanich, V. I., Sidney, V. I., Fitzgerald, V. I., Duncan, V. I., Ladysmith, V. I., Nanaimo, V. I., Departure Bay, V. I., Wellington, V. I., Alberni, V. I., Mt. Arrowsmith, V. I., Comox, V. I.

Bombus occidentalis var. **proximus** Cresson (8: 9♂ 3♀ 1☿—13)

LOCALITIES — Kaslo, Penticton, Vernon, Lytton, Hazelton, Atlin, Agassiz, Vancouver.

Bombus occidentalis var. **nigroscutatus** Franklin (1: 0♂ 0♀ 1☿—1)

LOCALITY—Kaslo, July 1, 1905, 1♀.

The following male colour variants of Franklin (1913) have been taken in British Columbia.

Male colour variant 3. (9: 11♂—11)

LOCALITIES — Fairview, Kaleden, Penticton, Westbank, Kamloops, Nicola, Tyee, Vancouver, Saanich, V. I.

Male colour variant 5. (5: 6♂—6)
LOCALITIES — Vernon, Kamloops, Smithers, Terrace, Tyee.
Male colour variant 7. (1: 1♂—1)
LOCALITY—Hazelton, Aug. 20, 1947, 1♂.
Male colour variant 8. (4: 4♂—4)
LOCALITIES — Kaslo, Kaleden, Chase, Walhachin.
Male colour variant 9. (2: 2♂—2)
LOCALITIES — Kaslo, Sept. 2, 1906. Salvus, Aug. 17, 1946.

B. occidentalis is a very common bumble bee in British Columbia and is exceeded in numbers only by *B. bifarius* Cresson. With its varieties and colour variants it has been taken in 77 localities, and as far north as collections have been made. As it is recorded from Alaska, Yukon and Northwest Territories, it is no doubt distributed throughout the Province. It appears to be equally at home in the dry interior valleys, on the sea coast, and in mountain meadows up to elevations of 6500 feet. It is a very abundant species in late summer along the Skeena River from Hazelton to Prince Rupert, where it may be found visiting the flowers of fire-weed, *Epilobium* sp.

The varieties *proximus* and *nigroscutatus* are rare, but males often show some variation, and 5 of Franklin's 9 male colour variants were found among the material on hand. Franklin (1913) records that this is one of the most variable of North American bumble bees, but the material from British Columbia does not appear variable, except the males to some extent. Out of 273 ♀♀ all were typical specimens of *occidentalis* except for 3♀ 1☿ of var. *proximus* and 1♀ of var. *nigroscutatus*, and the latter specimen was not at all definitely marked.

The writer has examined a very brilliantly marked worker color variant from Aklavik, at the mouth of the Mackenzie River, Northwest Territories, collected by Mr. A. G. Dustan (11.VII. 1946), in which the anterior part of the dorsum of the thorax was bright lemon yellow, the remainder entirely black; segment one of the abdomen entirely black; segment two, bright lemon yellow; segment three, black; segments four to six, clothed with long, pure white pile. A queen from Valdez, Alaska, collected by Mr. J. D. Gregson (15.VII.1948) also shows a brightly contrasting colouration, having the dorsum of the thorax, except for the interalar band, bright lemon yellow; abdominal segments one and two, black; segment three, lemon yellow; segment four, black; and segments five and six, with short, ferruginous-white pile—in some respects resembling var. *nigroscutatus*. It may be that colour variants of *occidentalis* are not uncommon in arctic America.

Bombus terricola Kirby (23: 75♂ 58♀ 58☿—191)
LOCALITIES—Vernon, Salmon Arm, Kamloops, Minnie Lake, Savona, Walhachin, Bridge Lake, Canim Lake, 100 Mile House, Williams Lake, Chilcotin, Quesnel, Prince George, Burns Lake, Quick, Smithers, Hazelton, Kitwanga, Cedarvale, Terrace, Rolla, Pouce Coupe, Vancouver.

B. terricola is the commonest of all the bumble bees in the central interior. It is particularly common from Williams Lake north to Prince George, and west through the Nechako and Bulkley valleys to Hazelton, and in diminishing numbers along the Skeena River to Terrace. It has not been recorded from the canyon of the Skeena or from the coast at Prince Rupert. Its range probably extends well beyond these areas into the northern interior, as it has been taken in the northeastern section of the Province, at Rolla and Pouce Coupe in the Peace River district, considerably north of latitude 56°. The altitude range of the localities listed above is from sea level to 3500 feet, but its habitat of maximum abundance, lying between latitudes 53° and 55°, has only an altitude range of 2000 to 3000 feet. To the south of Williams Lake, latitude 52°, it rapidly becomes less abundant, and is a distinctly uncommon species throughout the southern interior. It has not been recorded from southeastern British Columbia or from the southern Okanagan valley. There is one record of its capture on the coast at Vancouver, but there are no records from Vancouver Island.

This is a very distinctive species, readily identified in the field, and its relative abundance and scarcity north and south of latitude 52° is very striking. The series of 191 specimens from

23 localities shows a remarkably uniform colouration. Franklin (1913) records that the scutellum may be more or less yellowish and occasionally entirely yellow. In this series very few show any yellow hairs on the scutellum, and only one has the scutellum entirely yellow: a queen from the northernmost locality, Rolla.

This is a bumble bee of considerable economic importance in the central interior, where an alsike clover seed industry is rapidly developing. When these alsike fields are in flower *terricola* may be seen in great numbers working on the blooms in association with smaller numbers of *flavifrons*, *occidentalis*, and *melanopygus*.

B. terricola is closely related to *B. terrestris* L., which ranges throughout the greater part of Europe and Siberia. Franklin (1913) records *B. terrestris* var. *moderatus* Cresson from several localities in Alaska and considers that it probably occurs also in Yukon Territory. It is therefore possible that *terrestris* s. lat. may be found in the extreme northwestern corner of British Columbia.

Subgenus **Pratobombus** Vogt

Bombus ternarius Say (11: 56♂ 47♀ 140☿—243)

LOCALITIES — Crows Nest, Fernie, Golden, Chilcotin, Quesnel, Barkerville, Prince George, Vanderhoof, Fraser Lake, Burns Lake, Smithers.

This bumble bee is fairly common in the central plateau region of British Columbia from Chilcotin (latitude 52°), north to Prince George and northwest through the Nechako and Bulkley river valleys to Smithers (latitude 55°); it has been taken also in the Rocky Mountains at Crows Nest, Fernie, and Golden. It appears to be absent from the southern interior and coastal regions.

B. ternarius cannot be distinguished in the field from typical specimens of *bifarius* Cresson, and both occur together in the same rather restricted locations, where their queens may be seen in considerable numbers visiting dandelion flowers in June. *B. ternarius* is readily distinguished from *bifarius* on close examination by its having corbicular hairs black rather than bright ferruginous. When freshly emerged this is a very pretty species; but, as in typical specimens of *bifarius*, the bright salmon-red colour of the second and third abdominal segments soon fades and becomes yellowish.

Bombus huntii Greene (4: 0♂ 1♀ 2☿—3)

LOCALITIES—Crows Nest, Aug. 11, 1927, 1♀ 1☿. Fernie, July 27, 1946, 1☿. Vancouver I.; Fort McLeod; Franklin (1913).

B. huntii is a mountain form, and the only material seen by the author was collected in the Crows Nest Pass through the main range of the Rocky Mountains. Scullen (1927, 1930) records it as a very common species in the mountains of eastern Oregon. Franklin (1913) records *huntii* from Vancouver Island and from Fort McLeod, which is at latitude 55°, but does not give any data on the material collected. It may occur in fair numbers at moderate elevations in the Rocky Mountain regions of British Columbia.

Bombus vosnesenskii Radoszkowski (1: 1♂ 0♀ 2☿—3)

LOCALITY—Osoyoos, July 20, 1925, 1♂ 2☿.

This bumble bee is very rare in British Columbia. Scullen (1927) gives its range as "British Columbia to Southern California and east to Nevada" and states that it is by far the most common species in the lower altitudes of western Oregon; and Frison (1923) records it from Montana.

Osoyoos (elevation 913 ft.) is at the extreme southern end of the Okanagan Valley and on the border between British Columbia and the State of Washington. It is unlikely that *vosnesenskii* will be found much farther north but it may occur at Victoria, on the extreme southern tip of Vancouver Island, as it is considered by Franklin to belong to the Pacific Coast portion of the Transition Zone.

This is a species that might be confused with typical specimens of *californicus* in the field.

Bombus bifarius Cresson (32: 36♂ 64♀ 38☿—138)

[=B. *edwardsii* Cresson]
(Franklin, 1913, p. 328)

LOCALITIES—Fort Steele, Crows Nest, Okanagan Mission, Vernon, Field, Golden, Kamloops, Merritt, Nicola, Minnie Lake, Walhachin, Hat Creek, Clinton, Jesmond, 100 Mile House, Chilcotin, Alexis Creek, Soda

Creek, Quesnel, Prince George, Vanderhoof, Fraser Lake, Burns Lake, Quick, Smithers, Kitwanga, Agassiz, Vancouver, Victoria, V. I., Saanich, V. I., Fitzgerald, V. I., Alberni, V. I.

Bombus bifarius var. **vancouverensis** Cresson (38: 15♂ 69♀ 26♀—110)
[=B. *edwardsii* var. *vancouverensis* Cresson] (Franklin, 1913)

LOCALITIES — Invermere, Kaslo, Fairview, Okanagan Falls, Penticton, Keremeos, Kelowna, Okanagan Mission, Vernon, Golden, Revelstoke, Salmon Arm, Celista, Shuswap, Kamloops, Nicola, Minnie Lake, Clinton, Lillooet, Hazelton, Boston Bar, Buccaneer Bay, Pender Harbour, Victoria, V. I., Westholme, V. I., Goldstream, V. I., Royal Oak, V. I., Saanich, V. I., Sidney, V. I., Fitzgerald, V. I., Shawnigan, V. I., Duncan, V. I., Jordan Meadows, V. I., Sahtlam, V. I., Courtenay, V. I., Nanaimo, V. I., Departure Bay, V. I., Alberni, V. I.

Bombus bifarius var. **nearcticus** Handlirsch (55: 150♂ 95♀ 184♀—429)
[=B. *edwardsii* var. *nearcticus* Handl.] (Franklin, 1913)

LOCALITIES — Radium, Invermere, Premier Lake, Fort Steele, Crows Nest, Fernie, Cranbrook, Creston, Kaslo, Nelson, Oliver, Fairview, Vaseaux Lake, Okanagan Falls, Kaleden, Penticton, Keremeos, Hedley, Copper Mountain, Summerland, Peachland, Kelowna, Okanagan Mission, Vernon, Armstrong, Golden, Glacier, Revelstoke, Sicamous, Salmon Arm, Celista, Adams Lake, Kamloops, Merritt, Nicola, Minnie Lake, Clinton, Burns Lake, Quick, Smithers, Hazelton, Kitwanga, Atlin, Lillooet, Mt. McLean, Lytton, Boston Bar, Yale, Hope Mts., Agassiz, Victoria, V. I., Duncan, V. I., Alberni, V. I., Mt. Arrowsmith, V. I.

B. bifarius Cresson, with its two varieties, *vancouverensis* and *nearcticus*, is by far the commonest bumble bee in British Columbia, and this paper records 677 specimens from 83 localities, with an altitude range from sea level to at least 7000 feet in the southern interior. It undoubtedly occurs everywhere in the Province as far north as, or well beyond, latitude 55°.

B. bifarius has two very distinct and constant colour varieties, *bifarius* Cresson and *nearcticus* Handlirsch, and a third, *vancouverensis* Cresson, definitely intermediate in colouration between the other two. The distribution of these three forms in the Province is also sharply defined.

In the southern interior, south of latitude 51°, var. *nearcticus* is the dominant form and occurs in far greater numbers than the other varieties in their respective areas. Only a very light, but widespread, scattering of the other two forms is found in the southern interior. In var. *nearcticus* the pile of the thorax, other than the black interalar band, is pure white or nearly so, and the dorsum of the abdomen is black and white, with no trace of ferruginous markings. In the male the light pile is pale yellow. There is no other bee recorded from British Columbia that is likely to be confused with *nearcticus*.

In the central interior, north of latitude 51°, var. *bifarius* (described by Franklin, 1913, as *edwardsii* Cresson; see Frison, 1923, p. 317) is the dominant colour form, and only a very light scattering of *nearcticus*, and still less of *vancouverensis*, is found in this area. The colouration of var. *bifarius* is such a striking contrast to that of *nearcticus* that it is difficult to realize that they belong to the same species. In var. *bifarius* the light pile of the thorax is bright lemon yellow instead of white as in *nearcticus* and *vancouverensis*, and segments two and three of the abdomen are rich salmon-red. In the field, var. *bifarius* is readily confused with *B. ternarius*, which has an identical colour pattern, but black corbicular hairs, whereas those of *bifarius* are ferruginous.

On Vancouver Island and on the coastal areas of the mainland, var. *vancouverensis* is the dominant form. In the northern interior, where var. *bifarius* is dominant, *vancouverensis* appears to be very scarce; but it is not at all unusual to find occasional specimens throughout the range of *nearcticus* in the southern interior. Both var. *bifarius* and var. *nearcticus* are found also, in small numbers, on Vancouver Island and on the adjoining mainland, but these areas are mainly populated by var. *vancouverensis*. It is remarkable how these three colour forms of one species occur so constantly in separate geographic areas with so little intermingling.

B. bifarius var. *vancouverensis* is a strikingly handsome bee, with its sharply contrasting patchwork of white, black, and red. It is definitely inter-

mediate between the other two forms, having the light pile of the thorax pure white as in *nearcticus;* and abdominal segments two and three with salmon-red pile, sometimes completely so, as in var. *bifarius,* or in varying amounts.

Considerable confusion, both in literature and named specimens in collections, has resulted from Franklin's (1913) placing *B. bifarius* Cresson as a synonym of *edwardsii,* and describing the real *edwardsii* under the name of *fernaldae* Franklin (see Frison, 1923, p. 317).

Bombus sylvicola Kirby (7: 107♂ 32♀ 14♀—153)

LOCALITIES — Kaslo, Revelstoke, Kamloops, Walhachin, Barkerville, Vanderhoof, Mt. Cheam.

B. sylvicola is the most difficult of all British Columbia bumble bees to determine with certainty, some specimens being very difficult to separate from *B. melanopygus.* Typical specimens of *sylvicola,* in which there is no admixture of black hairs with the yellow pile of the anterior portion of the thorax, are easily distinguished. But in material from British Columbia there seems to be every gradation up to a condition almost comparable to that of typical specimens of *melanopygus.*

The material collected from Kaslo, Revelstoke, Barkerville, and Mt. Cheam was taken at an elevation of 6000 feet or over, whereas that from Kamloops, Walhachin, and Vanderhoof was from much lower elevations. The optimum altitude range for *sylvicola* is apparently from 6000 to 8000 feet. Though the localities where *sylvicola* has been collected are few, they are well distributed over the Province: Kaslo being in the southeastern corner; Revelstoke, Kamloops, and Walhachin in the southern interior; Barkerville and Vanderhoof in the central interior, and Mt. Cheam in the coastal area. Further collecting of this species is needed before any really satisfactory statement can be made as to its distribution and altitude range in British Columbia.

Mountain bumble bees have a short life, and are subjected to such violent winds and storms that they very quickly become faded and battered. It is very difficult to find time to visit such locations on a sufficient number of good collecting days to secure first the queens, then the workers, and lastly the males.

Bombus melanopygus Nylander (56: 116♂ 111♀ 126♀—353)

LOCALITIES—Radium, Invermere, Crows Nest, Boswell, Kaslo, Osoyoos, Vaseaux Lake, Okanagan Falls, Penticton, Copper Mountain, Summerland, Okanagan Mission, Vernon, Field, Golden, Glacier, Rogers Pass, Revelstoke, Sicamous, Salmon Arm, Celista, Merritt, Nicola, Clinton, Jesmond, Quesnel, Stanley, Barkerville, Salvus, Prince Rupert, Metlakatla, Rolla, Lillooet, Hope Mts., Manning Park, Agassiz, Mt. Cheam, Milner, New Westminster, Vancouver, Buccaneer Bay, Pender Harbour, Newcastle I., Victoria, V. I., Ucluelet, V. I., Royal Oak, V. I., Saanich, V. I., Sidney, V. I., Fitzgerald, V. I., Duncan, V. I., Cowichan Lake, V. I., Ladysmith, V. I., Nanaimo, V. I., Departure Bay, V. I., Tofino, V. I., Mt. Arrowsmith, V. I.

The 353 records of *B. melanopygus* from 56 localities indicate that this is a very common species, with a Province-wide distribution. It has a wide altitude range: from sea level to 8000 feet, with an optimum range of 0-6000 feet. It is particularly common on Vancouver Island, and on the coast of the mainland, and in the mountain meadows of the interior, where this species is readily confused with the strictly boreal species *B. sylvicola. B. melanopygus* occurs as far north as collecting has been done in British Columbia, and Franklin (1913) mentions that it is the commonest species in Alaska.

It is a strikingly handsome species which few entomologists would refrain from taking; this may account in some measure for the number of specimens in collections.

Bombus centralis Cresson (26: 80♂ 39♀ 83♀—202)

LOCALITIES—Invermere, Fernie, Kaslo, Osoyoos, Oliver, Fairview, Vaseaux Lake, Okanagan Falls, Kaleden, Penticton, Keremeos, Chopaka, Summerland, Peachland, Westbank, Kelowna, Vernon, Field, Salmon Arm, Kamloops, Merritt, Nicola, Minnie Lake, Walhachin, Chilcotin, Lillooet.

B. centralis has been recorded from 26 localities in the southern interior and southeastern regions of British Columbia. It occurs sparingly north to Chilcotin, latitude 52°, but does not appear to be present on Vancouver Island or the mainland coast.

In the field it closely resembles *B. flavifrons* but has a far more restricted range, occurring only in valleys with an altitude range of 1000 to 2000 feet.

Bombus flavifrons Cresson (66: 128♂ 79♀ 141☿—348)

LOCALITIES — Radium, Crows Nest, Fernie, Cranbrook, Kaslo, Oliver, Fairview, Okanagan Falls, Kaleden, Penticton, Summerland, Vernon, Field, Golden, Glacier, Revelstoke, Sicamous, Salmon Arm, Chase, Kamloops, Midday Valley, Nicola, Minnie Lake, Walhachin, Hat Creek, Bridge Lake, Canim Lake, Chilcotin, Quesnel, Barkerville, Prince George, Vanderhoof, Fraser Lake, Burns Lake, Quick, Smithers, Hazelton, Kitwanga, Cedarvale, Salvus, Metlakatla, Atlin, Lillooet, Mt. McLean, Lytton, Hope Mts., Agassiz, Milner, Vancouver, Buccaneer Bay, Powell River, Victoria, V. I., Royal Oak, V. I., Ucluelet, V. I., Saanich, V. I., Sidney, V. I., Fitzgerald, V. I., Shawnigan, V. I., Sahtlam, V. I., Cowichan, V. I., Nanaimo, V. I., Departure Bay, V. I., Wellington, V. I., Alberni, V. I., Mt. Arrowsmith, V. I., Courtenay, V. I.

Bombus flavifrons var. **dimidiatus** Ashmead (20: 14♂ 7♀ 25☿—46)

LOCALITIES—Invermere, Kaslo, Glacier, Hazelton, Inverness, Metlakatla, Centurian, Lytton, Hope, Hope Mts., Agassiz, Mt. Cheam, Crescent, Vancouver, Buccaneer Bay, Victoria, V. I., Westholme, V. I., Sidney, V. I., Fitzgerald, V. I., Tofino, V. I.

Bombus flavifrons var. **ambiguus** Franklin (3: 0♂ 0♀ 6☿—6)

LOCALITIES — Agassiz, Vancouver, Nanaimo, V. I.

B. flavifrons is one of the commonest species in the Province, and with its varieties, *dimidiatus* and *ambiguus*, has been represented by 400 specimens from 74 localities; only *B. bifarius* and *B. occidentalis* exceed it in numbers. It appears to be equally at home at sea level, in hot, dry locations, and in mountains up to 7000 feet. The typical form, *flavifrons* Cresson, is represented by 348 specimens from 66 localities; var. *dimidiatus*, by 46 specimens from 20 localities; and *ambiguus*, by 6 specimens from 3 localities. Both *dimidiatus* and *ambiguus* are readily confused with *B. sitkensis* and *B. mixtus* in the field, and are therefore hard to collect.

B. flavifrons has been observed to be of considerable economic importance in aiding in the pollination of alsike clover, in association with *B. terricola* and *B. melanopygus*.

Bombus pleuralis Nylander (1: 0♂ 2♀ 0☿—2)

LOCALITY—Vernon, May 15, 1920, 2♀.

Frison (1926, p. 135) gives the above record from Vernon, and also records this species as collected by Dyar and Caudell at Laggan, British Columbia; however, Laggan, now called Lake Louise, is in Alberta.

Bombus pleuralis var. **clarus** Frison (1: 0♂ 1♀ 0☿—1)

LOCALITY—Vernon, May 15, 1920, 1♀.

Frison (1926, p. 139) records this variety also from Laggan, British Columbia; this, as noted above, should be an Alberta record.

Except for these three queens, two being typical specimens of *pleuralis* and one a specimen of var. *clarus*, nothing is known of this species in British Columbia. Franklin (1912) records it only from Alaska.

Bombus sitkensis Nylander (42: 133♂ 67♀ 144☿—344)

LOCALITIES—Radium, Invermere, Fernie, Kaslo, Summerland, Vernon, Field, Golden, Revelstoke, Salmon Arm, Kamloops, Quesnel, Barkerville, Burns Lake, Smithers, Cedarvale, Salvus, Tyee, Prince Rupert, Inverness, Metlakatla, Boston Bar, Yale, Agassiz, Mt. Cheam, Hope Mts., Manning Park, Vancouver, Buccaneer Bay, Pender Harbour Newcastle I., Victoria, V. I., Ucluelet, V. I., Royal Oak, V. I., Sidney, V. I., Jordan Meadows, V. I., Nanaimo, V. I., Departure Bay, V. I., Alberni, V. I., Tofino, V. I., Comox, V. I., Courtenay, V. I.

B. sitkensis is a common species, easily confused with *B. mixtus* in the field. It has a Province-wide distribution and a wide altitude range. It is particularly common on Vancouver Island and the mainland coast and occurs in all sections of the Province where relatively cool, timbered areas occur. It is not found in any numbers in the arid, dry-belt regions of the southern interior. It is a common bumble bee in mountain meadows up to 7000 feet, and its optimum altitude range is from sea level to 6000 feet.

Bombus mixtus Cresson (64: 105♂ 130♀ 210☿—445)

LOCALITIES—Radium, Invermere, Crows Nest, Fernie, Cranbrook, Kaslo, Okanagan Falls, Penticton, Hedley, Copper Mountain, Summerland, Peachland, Okanagan Mission, Vernon, Field, Golden, Glacier, Revelstoke, Sicamous, Salmon Arm, Celista,

Adams Lake, Kamloops, Midday Valley, Nicola, Minnie Lake, Bridge Lake, Canim Lake, Chilcotin, Quesnel, Stanley, Barkerville, Prince George, Burns Lake, Smithers, Hazelton, Cedarvale, Salvus, Tyee, Prince Rupert, Metlakatla, Atlin, Rolla, Lillooet, Mt. McLean, Lytton, Yale, Hope Mts., Agassiz, Milner, Mission, Vancouver, Buccaneer Bay, Victoria, V. I., Westholme, V. I., Royal Oak, V. I., Saanich, V. I., Sidney, V. I., Fitzgerald, V. I., Ladysmith, V. I., Nanaimo, V. I., Departure Bay, V. I., Alberni, V. I., Courtenay, V. I.

B. mixtus is very common in British Columbia, and 445 specimens are here recorded from 64 localities. It is very evenly distributed over the Province. The northernmost record for British Columbia is Atlin, latitude 59°.

It prefers cool, wooded situations, and is equally at home on the coast or in the mountains of the interior; it is not found in any numbers in the dry-belt regions of the southern interior. Together with *B. sitkensis*, which it closely resembles, it is one of the commonest bumble bees in Vancouver. It has a wide altitude range, from sea level to at least 8000 feet in the mountains of the southern interior; its optimum range is from sea level to 6000 feet.

Bombus frigidus F. Smith (7: 2♂ 1♀ 2☿—5)

LOCALITIES — Invermere, Crows Nest, Kaslo, Kamloops, 100 Mile House, Chilcotin, Victoria, V. I.

This species is evidently rare in British Columbia, but the locality records show it to be widely distributed throughout the southern portion of the Province, including Vancouver Island. It is one of several bumble bees that cannot be distinguished in the field from some common species; this may account for the small number of specimens in the collections studied.

Bombus perplexus Cresson (6: 3♂ 1♀ 3☿—7)

LOCALITIES — Prince George, Burns Lake, Smithers, Salvus, Prince Rupert, Buccaneer Bay.

The locality records of *perplexus* indicate that it does not occur in the southern interior of the Province, but it is found in the central interior; in the Nechako, Bulkley, and Skeena river valleys, between Prince George and Prince Rupert; there is also one record from Buccaneer Bay, north of Vancouver.

B. perplexus cannot be distinguished from *B. vagans* in the field, and as *vagans* is particularly common in the territory where *perplexus* is found it is difficult to obtain a good series of the latter without killing large numbers of the former—something one dislikes to do.

Careful examination of several hundred specimens of *vagans* from all sections of the Province has revealed no specimens of *perplexus* except from the localities recorded above.

Bombus vagans F. Smith (47: 129♂ 82♀ 187☿—398)

LOCALITIES — Invermere, Fort Steele, Crows Nest, Creston, Kaslo, Lardo, Oliver, Westbank, Penticton, Summerland, Kelowna, Okanagan Mission, Vernon, Sugar Lake, Armstrong, Golden, Glacier, Revelstoke, Sicamous, Salmon Arm, Adams Lake, Shuswap, Kamloops, Merritt, Nicola, Minnie Lake, Canim Lake, Chilcotin, Quesnel, Stanley, Barkerville, Prince George, Fraser Lake, Burns Lake, Smithers, Hazelton, Kitwanga, Cedarvale, Terrace, Salvus, Metlakatla, Rolla, Hudson Hope, Hope Mts., Agassiz, Vancouver, Victoria, V. I.

B. vagans is one of the commonest species of bumble bees in the interior of British Columbia, and 398 specimens are here recorded from 49 localities. It prefers comparatively cool, timbered locations of moderate rainfall, and has not been taken in any numbers in the hot, arid regions of the southern Okanagan Valley or in extreme southeastern British Columbia. It is rare also in regions of heavy rainfall such as Vancouver Island and the mainland coast. It is found in maximum numbers from Vernon, in the North Okanagan Valley, northward through the southern and central interior regions, and is particularly abundant in the Nechako and Bulkley valleys from Prince George west to Terrace. It has also been taken at Rolla and Hudson Hope on the Peace River in northeastern British Columbia. Its abundance and distribution in the northern interior of the Province are unknown, and there appear to be no records of *vagans* from Alaska or Yukon Territory. Its optimum altitude range in British Columbia is from 1000 to 4000 feet.

Section *Odontobombus* Krüger

Subgenus **Subterraneobombus** Vogt

Bombus appositus Cresson (34: 88♂ 57♀ 37☿—182)

LOCALITIES — Invermere, Crows Nest, Cranbrook, Newgate, Kaslo, Nelson, Okanagan Falls, Penticton, Keremeos, Hedley, Summerland, Vernon, Glacier, Armstrong, Salmon Arm, Chase, Shuswap, Kamloops, Nicola, Minnie Lake, Walhachin, Hat Creek, Clinton, 100 Mile House, Chilcotin, Quesnel, Lillooet, Mt. McLean, Lytton, Chapmans, Yale, Hope, Agassiz, Vancouver.

The records of 182 specimens from 34 localities indicate that this is a fairly common species in the valleys of southeastern British Columbia and the southern interior. It occurs sparingly on the coast, and has not as yet been recorded from Vancouver Island. It is rare in the central interior but has been taken occasionally as far north as Quesnel (latitude 53°).

B. appositus is partial to dry open areas, where it may often be seen visiting thistles in company with *B. fervidus*, which it closely resembles in appearance, habits, and distribution.

Subgenus **Fervidobombus** Skorikov

Bombus fervidus (Fabricius) (16: 16♂ 39♀ 56☿—111)

LOCALITIES—Osoyoos, Oliver, Fairview, Kaleden, Penticton, Summerland, Peachland, Okanagan Mission, Vernon, Salmon Arm, Kamloops, Nicola, Minnie Lake, Walhachin, Ashcroft, Williams Lake.

Bombus fervidus var. **dorsalis** Cresson (7: 5♂ 4♀ 2☿—11)

LOCALITIES—Kaleden, Penticton, Salmon Arm, Kamloops, Nicola, Walhachin, Chilcotin.

B. fervidus, as well as its variety *dorsalis*, closely resembles *appositus*, but is less common. The records of the 111 specimens from 16 localities indicate that it is confined to the warm valleys of the southern interior. It has not been taken in southeastern British Columbia or to the west of the Coast Mountains. With the exception of two specimens from Chilcotin and Williams Lake (latitude 52°), all the records are from south of latitude 51°.

Bequaert (1932) gives some interesting notes of this species building their cells and rearing their broods in old birds' nests in trees.

When collecting insects in the Okanagan Valley in 1919, near the present townsite of Oliver, the author on several occasions placed his finger in the nests of the western marsh wren, *Telmatodytes palustris plesius* (Oberholser), to see whether they contained eggs, and was startled to have the nest vibrate violently and emit angry bumble bees. As he was not particularly interested in bees at that time, he did not determine the species. As *fervidus* is common in this district, it may have been this species that was making use of the wrens' nests. These little birds have the curious habit of building several spare nests, hanging them high up in the cat-tails: and these nests were evidently used by the bumble bees.

Bombus californicus F. Smith (24: 9♂ 23♀ 20☿—52)

LOCALITIES — Invermere, Creston, Penticton, Peachland, Westbank, Vernon, Armstrong, Salmon Arm, Chilcotin, Lytton, Hope, Agassiz, Langley, Crescent, Vancouver, Victoria, V. I., Royal Oak, V. I., Saanich, V.I., Sidney, V. I., Shawnigan, V. I., Nanaimo, V. I., Departure Bay, V. I., Alberni, V. I., Comox, V. I.

Bombus californicus var. **dubius** Cresson (9: 4♂ 8♀ 2☿—14)

LOCALITIES—Creston, Okanagan Falls, Westbank, Vernon, Agassiz, Vancouver, Victoria, V. I., Saanich, V. I., Nanaimo, V. I.

Bombus californicus var. **consanguineus** Handlirsch (35: 37♂ 71♀ 63☿—171)

LOCALITIES—Crows Nest, Fernie, Oliver, Fairview, Okanagan Falls, Kaleden, Penticton, Keremeos, Summerland, Vernon, Salmon Arm, Adams Lake, Kamloops, Walhachin, Clinton, Canim Lake, Chilcotin, Quesnel, Prince George, Quick, Smithers, Rolla, Arras, Centurian, East Pine, Agassiz, Mt. Cheam, Crescent, Vancouver, Victoria, V. I., Royal Oak, V. I., Saanich, V. I., Sidney, V. I., Fitzgerald, V. I., Wellington, V. I.

B. californicus, with its varieties *dubius* Cresson and *consanguineus* Handlirsch, is represented by 237 specimens from 49 localities. It is not a mountain bumble bee, but extends in the valleys over a wide area of the Province at an altitude range of 0-2000 feet.

B. californicus F. Smith, with the scutellum black, is represented by 52 specimens from 24 localities, and reaches its maximum abundance on Vancouver Island and the coast of the mainland. The variety *consanguineus*, with the scutellum yellow, is represented by 171 specimens from 35 localities and is the commonest of the three forms in British Columbia, ranging north to the central interior and Peace River district. The

variety *dubius*, with an admixture of black and yellow pile on the scutellum, is represented by 14 specimens from 9 localities. Though these definitely have some yellow pile, in varying amounts, mixed with the black on the scutellum, they are, in general, far more like the typical form than like var. *consanguineus*.

This is a fairly distinctive species in the field although the queens resemble those of *Psithyrus insularis*, but far more active.

Genus *PSITHYRUS* Tepeletier

This genus contains a small number of inquilinous, or "guest," bumble bees, without workers; the females utilize the nests of true bumble bees, their young being raised by the host workers.

Specimens of *Psithyrus* spp. are easy to collect, as they are sleepy and sluggish in their movements and often congregate in large numbers on flower heads of thistle, aster, and other attractive plants. This is particularly the case of males in late summer.

Psithyrus spp. may be readily distinguished from *Bombus* spp. by the absence of corbiculae, or pollen baskets, in the queens, and by the black, hairy faces of the males, the males of *Bombus* spp. having a conspicuous amount of yellow pile.

Seven species are known from America north of Mexico; and four of these, *insularis*, *ashtoni*, *suckleyi*, and *fernaldae*, are recorded from British Columbia. Of the remaining three species, *crawfordi*, described from Oregon, may well occur here; but *variabilis* is more southern in distribution and is less likely to be found. *P. laboriosus* has not as yet been recorded from British Columbia, but from its distribution in the U. S. it should be found here.

The species of *Psithyrus* closely resemble one another in size and in their black and yellow colouration, and in the field it is difficult to distinguish them. As *insularis* and *suckleyi* are exceedingly common and *ashtoni* and *fernaldae* are comparatively rare in British Columbia, it is difficult to secure good series of the latter two without collecting all specimens of *Psithyrus* seen.

Subgenus **Laboriopsithyrus** Frison

Psithyrus insularis (F. Smith) (56: 131♂ 131♀—262)

LOCALITIES — Carbonate, Radium, Invermere, Crows Nest, Fernie, Newgate, Kaslo, Osoyoos, Fairview, Okanagan Falls, Penticton, Hedley, Summerland, Okanagan Mission, Oyama, Vernon, Field, Golden, Glacier, Revelstoke, Sicamous, Salmon Arm, Kamloops, Merritt, Nicola, Aspen Grove, Walhachin, Hat Creek, Jesmond, Chilcotin, Quesnel, Stanley, Prince George, Vanderhoof, Burns Lake, Smithers, Kitwanga, Salvus, Lillooet, Lytton, Boston Bar, Hope, Hope Mts., Agassiz, Vancouver, Buccaneer Bay, Newcastle I., Victoria, V. I., Sidney, V. I., Fitzgerald, V. I., Duncan, V. I., Nanaimo, V. I., Departure Bay, V. I., Wellington, V. I., Mt. Arrowsmith, V. I., Forbidden Plateau, V. I.

This appears to be the only species of *Psithyrus* of which there are definite records of occurrence in the nests of *Bombus* spp. in British Columbia.

Frison (1921) records that Sladen (1915) found *P. insularis* in a nest of *B. flavifrons* at Agassiz on July 7, 1914. The author also received a queen of *insularis* and four workers of *B. mixtus* taken from a nest in a compost pile by H. B. Leech at Vernon on June 2, 1946. Mr. Leech stated that there was no sign of the *mixtus* queen which had evidently been killed or driven away by the *Psithyrus* sp.

This is the commonest species of *Psithyrus* in British Columbia, and this paper records 262 specimens from 56 localities widely and evenly distributed in the Province, at least as far north as latitude 56°, and with a considerable altitude range.

Subgenus **Ashtonipsithyrus** Frison

Psithyrus ashtoni (Cresson) (10: 75♂ 15♀—90)

LOCALITIES — Chilcotin, Quesnel, Barkerville, Prince George, Vanderhoof, Fraser Lake, Burns Lake, Quick, Smithers, Lillooet.

This is one of the rare species in British Columbia; and of the 10 localities recorded above, 9 are situated in the northern half of the Province, north of latitude 52°. The specimen from Lillooet, a little south of latitude 51°, was probably taken on Mt. McLean (altitude, 7600 ft.).

Psithyrus suckleyi (Greene) (51: 168♂ 85♀—253)

LOCALITIES—Carbonate, Invermere, Cranbrook, Kaslo, Nelson, Osoyoos, Oliver, Kaleden, Penticton, Keremeos, Peachland, Westbank,

Okanagan Mission, Vernon, Golden, Revelstoke, Sicamous, Salmon Arm, Adams Lake, Kamloops, Merritt, Nicola, Jesmond, Chilcotin, Quesnel, Prince George, Vanderhoof, Burns Lake, Smithers, Hazelton, Kitwanga, Cedarvale, Pacific, Terrace, Tyee, Lillooet, Lytton, Boston Bar, Yale, Hope Mts., Manning Park, Agassiz, Mt. Cheam, Vancouver, Buccaneer Bay, Victoria, V. I., Royal Oak, V. I., Duncan, V. I., Sahtlam, V. I., Ladysmith, V. I., Departure Bay, V. I.

P. suckleyi is similar to *insularis* in having a Province-wide distribution and a considerable altitude range. It is a common species, and the 253 specimens recorded were collected from 51 localities, ranging from latitude 49° to north of latitude 55° and from the Alberta border to Vancouver Island.

Subgenus **Fernaldaepsithyrus** Frison

Psithyrus fernaldae Franklin (20: 63♂ 15♀—78)

LOCALITIES — Invermere, Kaslo, Summerland, Vernon, Field, Revelstoke, Hat Creek, Jesmond, Chilcotin, Barkerville, Metlakatla, Stikine, Hope Mts., Manning Park, Agassiz, Mt. Cheam, Vancouver, Newcastle I., Departure Bay, V. I., Nanaimo, V. I.

P. fernaldae is a comparatively rare species but is more widely distributed than *ashtoni*, and the 80 specimens recorded were collected in 21 localities from latitude 50° to the Yukon boundary. The Kamloops collection also contains 7 males collected on July 15, 1948, at Valdez, Alaska, by J. D. Gregson. It has been taken at several points at sea level on the coast, but the specimens from the interior are mainly from mountain locations as high as 7000 ft. Further collecting is needed to determine its distribution and altitude range in British Columbia.

The Canadian National Collection, at Ottawa, contains 2 males of *fernaldae* var. *wheeleri* Bequaert and Plath, collected at Revelstoke on August 12, 1923, by P. N. Vroom. These were evidently mislabelled, as a check with specimens of *fernaldi* s. str. and a comparison with the type of *wheeleri* kindly undertaken by Dr. J. Bequaert, Museum of Comparative Zoology, Cambridge, Mass., clearly reveal that these two males are typical specimens of *fernaldae* and not of var. *wheeleri*.

In some unpublished notes, kindly loaned by Dr. H. H. Ross, Illinois State Natural History Survey, Frison also records var. *wheeleri* from Vancouver, B. C. But the writer has not obtained any data on this record, and as it might have been in error as in the case of the Revelstoke material, var. *wheeleri* is not being recorded here as occurring in British Columbia. It may, however, be found in the Province, as it occurs in both Oregon and California.

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AN UNUSUAL CUTWORM OUTBREAK[1]

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Early in August, 1948, a report was received at the Dominion Entomological Laboratory, Agassiz, B. C., of a serious cutworm outbreak on Nicomen Island. This island, composed entirely of alluvial land, lies on the north side of the Fraser River east of Mission and is some 7 miles long. It was almost entirely covered with water to a depth of many feet during the disastrous flood in June, 1948, and all crops were destroyed.

Investigation showed a large, striped, greenish caterpillar to be present in epidemic numbers, feeding on the scanty vegetation that was then springing up as the land dried. The larvae were in various instars, but the majority were fully fed.

As the insect was not recognized, material was collected for rearing. The adults emerged throughout September, 1948 and were identified as *Dargida procincta* (Grote).

Search of literature showed no record of this insect as a pest in British Columbia, but W. Downes, lately in charge of the Dominion Entomological Laboratory at Victoria, has since informed me that, in 1928, a serious outbreak occurred in the Alberni, Comox, and Cumberland areas, where, chiefly on bottom lands, clover, alfalfa, young oats and couch grass were severely injured. J. R. J. Llewellyn Jones of Cobble Hill, Vancouver Island, also told me that he captures an occasional adult in most years.

Later in August, outbreaks were also reported in the Glendale, Matsqui, and Hatzic areas, where similar flood conditions had obtained. The total area covered by the outbreak of this uncommon species was therefore some 200 square miles.

The larvae were found to feed on a variety of plants, chiefly grasses, oats, and corn; but the new growth of dandelion, plantain, and other weeds that had survived a three-week submergence were fed upon until the newly sown grain crops came through the mud. In some fields 25 per cent of the oat and corn seedlings were devoured. Feeding was general during daylight hours, this species having somewhat the habits and appearance of an armyworm.

A 3 per cent D.D.T. dust proved an effective and practical control.

Two interesting facts concerning the life-history of this species were noted. The first is the sudden and unexplained appearance of the larvae in numbers sufficiently large to give rise to an epidemic, for this species is seldom seen in an average year. The second is the complete confinement of the outbreak to flooded lands. It was particularly noticeable on Nicomen Island that even small ridges above flood level were not infested. In the latter connection it is interesting to refer to the observations made by Professor Spencer (1947), when it was noted that the moths of this species oviposited only in soil being soaked by a garden hose and were uninterested in the garden beds not being watered. Evidently only water-soaked land is chosen by the adults for egg-laying.

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[1] Contribution No. 2622A, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

NOTES ON THE LIFE HISTORY OF FEBRUARY HIGHFLYER HYDRIOMENA NUBILOFASCIATA PACK. F. VULNERATA SWETT (Lepidoptera: Geometridae)

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The species of the genus *Hydriomena* are very variable yet difficult to separate and since any facts concerning the life-histories may be useful in determining their true status, the following notes on *Hydriomena nubilofasciata* Pack. f. *vulnerata* Swett. are presented.

The February highflyer is quite common and in some years very abundant about trees of the Garry oak, *Quercus garryana* Doug., in the vicinity of Victoria, B. C. During the flight period, February and March, the moth is readily attracted to artificial light. By day it rests on tree trunks, the underside of branches, copings, or any place that will provide seclusion away from direct sunlight. It is very alert and is not easy to approach when at rest, for it takes flight quickly and usually before it can be seen by a would-be captor.

As the intention was to investigate the details of its life-history, females were particularly sought in order to obtain a supply of eggs. It was found that those individuals that came to light, especially during the early part of the season, were males; females were taken more commonly towards the end of the flight period, although by that time most of them had already deposited their eggs. After a few futile attempts to obtain gravid females it was discovered that the best method was to search the bushes and adjacent herbage or low hanging branches of the oaks, with a torch or lantern, when it was possible to find an occasional specimen either in copulation or quietly resting.

The following observations were made during the spring of 1949. Partly due to the elusive habits of the larvae the exact sequence of the moults was not precisely ascertained, hence a more or less chronological account has been adopted.

Ovum. Laid on March 26, 1949. Length 1 mm., width .05 mm. Elongate oval, slightly flattened at one end, surface minutely pitted or recticulated, smooth, shining. Colour white, turning to a light cinnamon towards hatching time.

The eggs were laid indiscriminately on the sides of the jar or over oak twigs inserted for the purpose. One female taken under natural conditions had packed her eggs into the dried and empty capsule of a garden *linaria*, far removed from any oak twigs. The number of eggs obtained from each of several females was 10 to 18. These were laid between March 5 and 26.

Larva. April 17: emerged from egg. 1st instar, length 1 mm. Head black, body dull green, smooth. The larva does not eat the egg shell, but immediately seeks a bud that is just breaking and burrows into the centre where it remains concealed in a little cell hollowed out by eating into the substance of the bud.

April 26: Length 4 mm. Head black, body drab fuscous brown, smooth, shining. The only external evidence of life in the bud is the accumulation of frass between the incipient leaves. Judging by the size of the larvae this may be the 2nd or 3rd instar. Some larvae were just undergoing a moult.

April 29: Moult completed. Length now 6 mm. Colour and appearance as before. Some of the larvae show signs of leaving the bud which is rapidly opening into leaf.

May 1: Evidently another and unobserved moult has been effected. Length now 8 mm. Head brown with black flecks, body dull black with three indefinite longitudinal dorsal lines of small beige-coloured spots. Ninth abdominal segment pale beige. The larvae are still feeding concealed between base of leaves of the young shoot.

May 2: Length 12 mm. Head brown with black flecks, body black with four milky-white interrupted lines on dorsum and similar lateral lines, ventral surface lighter in colour.

May 4: As the leaves grow the larvae resort to folding over the leaf tip or hiding between two leaves where they lie concealed, usually curled up. They feed on the parenchyma, leaving the upper surface of the leaves intact. When disturbed they snap the fore part of body back and forth.

May 6: Evidently the 4th or 5th instar. Length 15 mm. Head light brown as before, body *creamy green* with interrupted dorsal and lateral lines dusky. Spiracles black. The larvae continue to feed under cover of folded leaves. If violently disturbed they escape from the leaves and suspend themselves by a silken thread.

May 8: Length 20 mm. Colour and markings as before but more decided in tone.

May 11: Length 24 mm. This may be the 5th or 6th instar. Colour as before but richer and markings more pronounced. The larvae consistently seek cover between folded portions of the leaves.

Pupa. Pupation May 21 in fold of leaf or in a light silken cocoon spun in the sand at bottom of cage. Particles of sand adhered to the cocoon rendering it almost invisible. Length 11 mm., width 3 mm. Colour light brown turning to dark brown in 24 hours, smooth, shining. Cremaster with two long hooked setae and several very short ones at base. The pupae were kept throughout the summer at average room temperature.

Imago. Emerged January 19, 26 and February 8, 1950. Two males and one female. The first recorded emergence under natural conditions was February 18.

Remarks. There are several interesting features in the life-history of this species. *First*, the larva is completely a bud feeder in the early stages, completing its growth concealed in folded leaves. *Second*, the change of colour from black to green may be significant as the colour matches the green leaves on which growth is completed, thus rendering the larvae less conspicuous. *Third*, from the unusual length of the pupal period, it might be expected that a second brood would intervene between the spring of one year and that of the next, but the newly opened bud seems to be an essential requirement for the young larvae.

Summary. The February highflyer, *Hydriomena nubilofasciata* f. *vulnerata* feeds in the larval stage on Garry oak, *Quercus garryana*. The adult is on the wing in the months of February and March. The eggs are assumed to be laid on or near the buds, in which the larvae feed. The larvae change colour from black to green as the leaves develop. The pupal stage which is passed in the ground lasts for about nine months or until the opening buds are ready for the newly hatched larvae. The life cycle as here observed is divided between the stages as follows, ova—22 days, larvae —34 days, pupae—243 days, imagines —over a period of 60 days.

A FURTHER NOTE ON BREEDING LAMBDINA FISCELLARIA SOMNIARIA HIST.

Supplementary to my previous experiment with the larvae of **Lambdina fiscellaria somniaria Hist.**, reported in the Proceedings of the Entomological Society of British Columbia, Volume 45, page 6, this note is now submitted.

On June 2, 1949, while "beating" Garry oak, **Quercus garryana** Douglas, in the Uplands District of Victoria, B. C., 21 very small larvae of this species were obtained. On June 26, when about half an inch in length, the larvae were sleeved on western hemlock, **Tsuga heterophylla.** The small larvae readily accepted this food and thrived and by August 22, 18 of them had pupated in the folds of the sleeve. Three larvae were in their rudimentary cocoons in a dormant state. They were transferred to a ten inch flower-pot, in which some soil had been placed and on which a generous layer of moss was spread. The pupae, after removal from their cocoons, together with the three "resting" larvae which were left in their flimsy cocoons, were placed on the moss.

Sixteen imagines were obtained between August 3 and October 3, 1949. The imagines were of normal size and in colouring were very similar to typical **somniaria**, though possibly a trifle greyer than is generally the case when the larvae have fed exclusively on Garry oak.—J. R. J. Llewellyn Jones, Cobble Hill, B. C.

BIOLOGICAL CONTROL INVESTIGATIONS IN BRITISH COLUMBIA[1]

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Since the initial introduction of natural enemies of insects into British Columbia in 1917, 42 species of parasites and predators have been released against 21 species of pest insects. This comparatively large-scale importation of beneficial insects was undertaken in an effort to control the important insect pests that have become established in the Province without their natural enemies. The geographic location and topography of British Columbia presented barriers that prevented these enemies from reaching the area unassisted.

The topography and climate of British Columbia separate it ecologically from the rest of Canada, and subdivide it into a number of more or less clearly defined ecological islands. The mountains form natural physical barriers that restrict the movement and distribution of insect species and through their effect on climate produce a wide range of temperature and precipitation that places a further restriction on distribution. This increases the number of problems in biological control of insects, but also provides many advantages for the application of this method of control that are not found in less restricted areas.

An indication of the wide range of climate in British Columbia is given in the following records provided by the Meteorological Division of the Department of Transport. The statistics are annual averages.

	Maximum	Minimum
Precipitation	Northern coast, 112.11"	Interior, 9.02"
Snowfall	Eastern interior, 390.2"	Vancouver Island, 6.3"
Extreme High Temperature	Central interior, 103° F.	Northern coast, 75° F.
Extreme Low Temperature	Northern interior, –45° F.	Vancouver Island, 20° F.
Sunshine	Vancouver Island, 2207 hrs.	Northern coast, 1053 hrs.

These extremes of climate are responsible for great variation in the flora in the different areas, and this has an important effect on the insect species through restricting them to the areas where their host plants grow. The number of plant species has been greatly increased through the introduction of new crops that are continually being added to the diversified agricultural areas. Many of the economically important insect pests accompanied the original or later importations of their host plants before the Division of Plant Protection reduced this hazard to the minimum. There are still ways by which new insect pests may be introduced and become established in the Province in spite of the most careful inspection at ports of entry. Evidence of the continued increase in the number of insect pests that have become established in British Columbia is contained in Table I, which includes a partial list of the species that have been recorded since 1900.

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TABLE I

A partial list of insect pests recorded for the first time in British Columbia since 1900.

COMMON NAME	SCIENTIFIC NAME	DATE FIRST RECORDED
Codling moth	*Carpocapsa pomonella* (L.) (Vancouver Island)	1900
	(Interior)	1905
Greenhouse whitefly	*Trialeurodes vaporariorum* (Westw.)	1907
Apple mealybug	*Phenacoccus aceris* (Sign.)	1913
Pea weevil	*Bruchus pisorum* (L.)	1915
European earwig	*Forficula auricularia* L.	1916
Satin moth	*Stilpnotia salicis* (L.)	1920
Lecanium scale	*Lecanium coryli* (L.)	1923
Larch sawfly	*Pristiphora erichsonii* (Htg.)	1930
Cabbage seedpod weevil	*Ceutorhynchus assimilis* (Payk.)	1931
Pea moth	*Laspeyresia nigricana* (Steph.)	1933
Carrot rust fly	*Psila rosae* (F.)	1936
Soft scale	*Coccus hesperidum* (L.)	1938
Lodgepole needle miner	*Recurvaria milleri* (Busck)	1942

The first introduction of natural enemies of insects into British Columbia occurred in 1917, when the predacious mite *Hemisarcoptes malus* (Shimer) was obtained in New Brunswick and released on Vancouver Island, on the lower mainland, and in the Okanagan Valley against the oystershell scale.

A few additional parasite species were introduced before 1929, but prior to that time there were no suitable facilities in Canada to provide pure parasite cultures for release. After the establishment of the Dominion Parasite Laboratory at Belleville, Ontario, in 1939, a modern laboratory with quarantine facilities was constructed, and under the direction of A. B. Baird, Officer-in-Charge, Biological Control Investigations, the importation, propagation, and distribution of parasites proceeded rapidly. The distribution and successful establishment of many of the species that have been introduced into British Columbia would not have been possible, however, without the active co-operation of the local entomologists. The method by which a parasite of the European earwig, i.e., *Bigonichaeta setipennis* (Fall.), was established provides a good example of this co-operation. Colonies of this parasite obtained from England through the Belleville laboratory and released at New Westminster between 1920 and 1931 did not give evidence of becoming established. Arrangements were made by A. B. Baird in 1933 to procure breeding stock from the city of Portland, Oregon, where propagation and distribution of the parasite was then in progress. A breeding station was set up at the Dominion Entomological Laboratory at Victoria, and R. W. Smith of the Belleville laboratory assisted W. Downes in the development of suitable facilities and the establishment of propagation routine. The work was continued for several years by W. Downes and H. Andison, and more than a quarter of a million parasites were released during the period 1934 to 1939 with the result that the species became established over a wide area.

Reports concerning the establishment of many of the introduced parasites have been published by a number of entomologists including Venables (1923, 1931), Glendenning (1931), Downes and Andison (1941), Hopping, Leech, and Morgan (1943), Wishart (1947), Spencer (1947), and Baird and McLeod (1949).

An alphabetical list of all species of parasites and predators introduced and the pest species against which they have been released is given in Table II.

TABLE II

Species of parasites and predators introduced into British Columbia during the period 1917 to 1949.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
Allotropa sp.	Apple mealybug, *Phenacoccus aceris* (Sign.)	Nelson	1938	Nova Scotia	2,080
Allotropa utilis Mues.	Apple mealybug, *Phenacoccus aceris* (Sign.)	Boswell	1939	Nova Scotia	44
		Boswell	1940	"	190
		Creston	1940	"	240
		Long Beach	1940	"	17
		Kelowna (Okanagan Mission)	1941	"	21
		Okanagan Mission	1942	"	106
		Robson	1942	"	252
		Bonnington & S. Slocan	1943	"	1,340
		Gray Creek	1943	"	1,535
		Queen's Bay	1943	"	777
		Boswell & Dist.	1944	N. S., through B. C.	628
		Queen's Bay	1944	"	427
		Willow Pt. & Nelson	1944	"	762
		Okanagan Mission	1945	"	2,732
		Royal Oak (Victoria)	1948	"	133
Apanteles solitarius (Ratz.)	Satin moth, *Stilpnotia salicis* (L.)	Nicomen Is.	1933	Europe, through U. S. A.	737
Aphelinus mali (Hald.)	Woolly apple aphid, *Eriosoma lanigerum* (Hausm.)	Vernon	1929	Ontario	516
		Vancouver	1921	"	?
Aphelinus sp.	Aphids	Victoria	1938	Belleville	2,500
Ascogaster carpocapsae (Vier.)	Codling moth, *Carpocapsa pomonella* (L.)	Kelowna	1933	Ontario	1,097
		Winfield	1934	"	421
		Kelowna	1935	"	599
		Penticton	1935	"	622
		Victoria	1935	"	1,739
		Winfield	1935	"	1,043
		Victoria	1936	"	1,144
		Kamloops North	1937	"	1,156
		Keating	1937	"	871
		Kelowna	1937	"	3,295
		Oyama	1937	"	572

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
Ascogaster carpocapsae (Vier.)		South Okanagan	1937	"	291
		Vernon	1937	"	725
		Victoria	1937	"	560
		Winfield	1937	"	2,845
		Victoria	1939	"	570
		Vernon	1939	"	33,250
Ascogaster quadridentata Wesm.	Pea moth, *Laspeyresia nigricana* (Steph.)	Chilliwack	1936	Ontario	300
		Sumas Prairie	1936	"	966
		East Chilliwack	1937	"	50
Bessa harveyi (TT) *selecta* Mgn. of American auth.)	Pea moth, *Laspeyresia nigricana* (Steph.)	Sumas Prairie	1937	England	34
		Chilliwack	1938	"	127
		Musselwhite	1938	"	753
		Chilliwack	1939	"	4,377
		Cloverdale	1947	"	3,592
Bigonichaeta setipennis (Fall.)	European larch sawfly, *Pristiphora erichsonii* (Htg.)	Edgewood	1942	New Brunswick & Ontario	3,750
		Vernon	1942	"	2,245
	European earwig, *Forficula auricularia* (L.)	New Westminster	1928	England & U.S.A.	165
		New Westminster	1929	"	212
		New Westminster	1930	"	326
		New Westminster	1931	"	373
		Sidney	1934	"	200
		Chemainus	1935	"	2,000
		Victoria	1935	"	17,500
		Alberni	1936	"	1,000
		Courtenay	1936	"	1,000
		Cumberland	1936	"	1,000
		Forbes Landing	1936	"	1,000
		Gordon Head	1936	"	1,000
		Keating	1936	"	1,000
		Ladysmith	1936	"	1,000
		Little Qualicum	1936	"	1,000
		Nanaimo	1936	"	5,000
		New Westminster	1936	"	5,000
		North Vancouver	1936	"	4,000
		Parksville	1936	"	1,000
		Port Alberni	1936	"	1,000
		Powell River	1936	"	4,000
		Qualicum	1936	"	1,000
		Royston	1936	"	1,000

SPECIES HOST LOCALITY YEAR ORIGIN NUMBER RELEASED

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
		Qualicum	1936	"	1,000
		Royston	1936	"	1,000
		Salt Spring Is.	1936	"	1,000
		Vancouver	1936	"	32,019
		Victoria	1936	"	4,200
Bigonichaeta setipennis (Fall.)[1]		Agassiz	1938	Europe, through U. S. A. (Victoria)[2]	5,000
		Campbell River	1938	"	3,000
		Cloverdale	1938	"	1,000
		Cobble Hill	1938	"	2,000
		Comox	1938	"	2,000
		Courtenay	1938	"	4,000
		Craig's Crossing	1938	"	1,000
		Duncan	1938	"	4,000
		Errington	1938	"	2,000
		Haney	1938	"	5,000
		Horseshoe Bay	1938	"	1,000
		Ladysmith	1938	"	1,000
		Langford Lake	1938	"	1,000
		Lantzville	1938	"	1,000
		Milner	1938	"	1,000
		Nanoose	1938	"	1,000
		Nelson	1938	"	8,000
		New Westminster	1938	"	1,000
		Parksville	1938	"	1,000
		Port Coquitlam	1938	"	5,000
		Powell River	1938	"	8,000
		Qualicum Beach	1938	"	2,000
		Quathiaski Cove	1938	"	1,000
		Salt Spring Is.	1938	"	3,000
		Sandwick	1938	"	1,000
		Saseenos	1938	"	1,000
		Sooke Village	1938	"	2,000
		Squamish	1938	"	1,000
		Ten Mile Point	1938	"	2,120
		Union Bay	1938	"	1,000
		Vancouver	1938	"	3,000
		Vernon	1938	"	2,000
		Victoria	1938	"	15,775
		West Bay	1938	"	1,000
		Westview	1938	"	1,000
		Wildwood Heights	1938	"	1,000
		Brentwood	1939	"	1,000
		Cowichan Lake	1939	"	1,000
		Esquimalt	1939	"	1,893

[1] Comprised of parasitized earwigs and parasite puparia.
[2] European earwig parasites propagated at the Dominion Entomological Laboratory, Victoria, B. C., from breeding stock obtained in Portland, Ore.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
Bigonichaeta setipennis (Fall.)[1]		Gibson's Landing	1939	"	2,000
		Mt. Douglas	1939	"	1,000
		North Galiano Is.	1939	"	1,000
		Royal Oak	1939	"	1,000
		Westholme	1939	"	1,000
Blastothrix sericea (Dalm.)	Lecanium scale, *Lecanium coryli* (L.)	Vancouver	1928	England	263
		Vancouver	1929	"	779
Bracon sp.	Cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.)	Victoria	1944	British Columbia	443
		Gordon Head	1945	"	133
		Blenkinsop Rd.	1946	"	55
		Mattick's Farm	1946	"	610
Calosoma sycophanta (L.)	Oak looper, *Lambdina somniaria* (Hulst)	Vancouver Is.	1917-1918	Europe, through U. S. A.	?
Chrysocharis gemma (Wlk.)	Holly leaf miner, *Phytomyza ilicis* (Curt.)	Victoria	1936	England	3,166
		Victoria	1937	"	10,331
		Victoria	1938	"	21,067
		Burnaby	1939	"	2,136
		Essondale	1939	"	2,550
		Vancouver	1939	"	4,696
		West Vancouver	1939	"	2,011
Chrysocharis syma Wlk.	Holly leaf miner, *Phytomyza ilicis* (Curt.)	Victoria	1936	"	469
		Saanich (Finnerty Bay)	1937	"	1,035
		Victoria	1938	"	474
		Vancouver	1939	"	179
Coccophagus scutellaris (Dalm.)	Soft scale, *Coccus hesperidum* (L.)	Victoria	1942	U. S. A.	139
Compsilura concinnata (Meig.)	Satin moth, *Stilpnotia salicis* (L.)	Coquitlam	1929	Europe, through U. S. A.	526
		Agassiz	1930	"	834
		Agassiz	1931	"	589
		Agassiz	1932	"	242
		Seton Lake	1933	"	694
		Agassiz	1934	"	45
		Lillooet	1934	"	662
Cryptus sexannulatus Grav.	Codling moth, *Carpocapsa pomonella* (L.)	Kelowna	1942	Europe (Belleville)[3]	54
		Kelowna	1946	"	2,185
		Penticton	1946	"	2,014

SPECIES HOST LOCALITY YEAR ORIGIN NUMBER RELEASED

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
Cryptus sexannulatus (Grav.)		Penticton	1946	"	2,014
		Brilliant	1947	"	23
		Salmon Arm	1947	"	193
Cyrtogaster vulgaris Wlk.	Holly leaf miner, *Phytomyza ilicis* (Curt.)	Saanich	1937	England	148
		Victoria	1938	"	2,079
		Vancouver	1939	"	332
		West Vancouver	1939	"	139
Dacnusa gracilis (Nees)	Carrot rust fly, *Psila rosae* (F.)	Cloverdale	1949	"	1,153
Dahlbominus fuscipennis (Zett.)	Hemlock sawfly, *Neodiprion tsugae* Midd.	Yale	1941	Europe (Belleville)[3]	100,000
		Sugar Lake region 40 mi. from Vernon	1941	"	300,000
Drino (Prosturmia) bohemica Mesnil	Hemlock sawfly, *Neodiprion tsugae* Midd.	Kwuna Point	1946	Europe (Belleville)[3]	201
		Welcome Point (Skidegate Inlet)	1946	"	314
Encarsia formosa Gahan	Greenhouse whitefly, *Trialeurodes vaporariorum* (Westw.)	British Columbia	1934	Belleville	119,700
		British Columbia	1935	"	126,400
		British Columbia	1936	"	77,145
		British Columbia	1937	"	194,600
		British Columbia	1938	"	410,400
		British Columbia	1939	"	415,300
		British Columbia	1940	"	394,000
		British Columbia	1941	"	472,000
		British Columbia	1942	"	275,000
		British Columbia	1943	"	172,000
		British Columbia	1944	"	217,000
		British Columbia	1945	"	337,000
		British Columbia	1946	"	223,000
		British Columbia	1947	"	101,000
		British Columbia	1948	"	191,500
		British Columbia	1949	"	135,000
Ephialtes caudatus Ratz.	Codling moth, *Carpocapsa pomonella* (L.)	Vernon	1941	Europe (Belleville)[3]	160
		Kelowna	1946	"	1,265
		Penticton	1946	"	1,369
		Brilliant	1947	"	44
		Creston	1947	"	35
		Salmon Arm	1947	"	157
Eupteromalus nidulans (Thoms.)	Satin moth, *Stilpnotia salicis* (L.)	Boston Bar	1933	Europe, through U. S. A.	30
		Chilliwack	1933	"	2,500
		Rosedale	1933	"	1,783

[3] Parasites propagated at the Dominion Parasite Laboratory, Belleville, Ont., from imported breeding stock.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
Eupteromalus nidulans (Thoms.)		Seton Lake	1933	"	2,470
		Lillooet	1934	"	4,900
Glypta haesitator Grav.	Pea moth, *Laspeyresia nigricana* (Steph.)	Chilliwack	1938	England	734
		Chilliwack	1939	"	809
		Cloverdale	1947	England, through B. C.	371
Habrocytus sp.	Cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.)	Sardis	1949	Europe	183
Hemisarcoptes malus (Shimer)	Oystershell scale, *Lepidosaphes ulmi* (L.)	Agassiz	1917	New Brunswick	1000+
		Mission	1917	"	1000+
		Royal Oak	1917	"	1000+
		Vernon	1917	"	1000+
Horogenes spp.	Pea moth, *Laspeyresia nigricana* (Steph.)	E. Chilliwack	1937	England	14
		Chilliwack (sp. A.)	1939	"	3
		Chilliwack (sp. B.)	1939	"	18
Leptomastidea abnormis (Gir.)	Citrus mealybug, *Pseudococcus citri* (Risso)	British Columbia	1940	Sicily, through U. S. A. (Belleville)[3]	400
		British Columbia	1941	"	1,300
Leptomastix dactylopii How.	Citrus mealybug, *Pseudococcus citri* (Risso)	British Columbia	1939	South America, through U. S. A. (Belleville)[3]	600
		British Columbia	1940	"	450
		British Columbia	1941	"	6,500
		British Columbia	1942	"	1,000
Macrocentrus ancylivorous Rohw.	Pea moth, *Laspeyresia nigricana* (Steph.)	Sumas Prairie	1935	U. S. A. (Belleville)[3]	175
		Chilliwack	1936	"	402
		Sumas Praisie	1936	"	324
Mantis religiosa L.	Grasshoppers, *Melanoplus* and other spp.	Kamloops	1937	Europe, through U. S. A. (Belleville)[3]	38
		Vernon	1937	"	123
		Salmon Arm	1938	"	175
Mantis religiosa L.[4]	Grasshoppers, *Melanoplus* and other spp.	Vernon	1937	Europe, through U. S. A. (Belleville)[3]	491
		Vernon	1938	"	175
Mesoleius aulicus (Grav.)	European larch sawfly, *Pristiphora erichsonii* (Htg.)	Fernie	1934	England, through Que., Ont. & N. B.	673
		Hosmer	1935	"	1,861
		Rosen Lake	1935	"	335
		Fernie	1936	"	49
		Kitchener	1936	"	388

[4] Egg masses.

		Fernie	1936	"	49
		Kitchener	1936	"	388

[4] Egg masses.

SPECIES	HOST	LOCALITY	YEAR	ORIGIN	NUMBER RELEASED
Mesoleius aulicus Grav.		Lumberton	1936	"	105
		Rosen Lake	1936	"	239
		Edgewood	1941	"	330
		Inonoaklin River	1941	"	294
		Edgewood	1942	"	302
		Vernon	1942	"	400
Metaphycus stanleyi (Comp.)	Soft scale, *Coccus hesperidum* (L.)	Victoria	1942	U. S. A.	40
Meteorus versicolor (Wesm.)	Satin moth, *Stilpnotia salicis* (L.)	Lillooet	1934	Europe, through U. S. A.	520
Opius ilicis Nixon	Holly leaf miner, *Phytomyza ilicis* (Curt.)	Victoria	1938	England	33
		Vancouver	1939	"	10
Pristomerus vulnerator Panz.	Pea moth, *Laspeyresia nigricana* (Steph.)	Chilliwack	1938	England	5
Protodexia australis Bl.	Grasshoppers, *Melanoplus* and other spp.	Kamloops	1947	Argentina	280
Sphegigaster flavicornis Wlk.	Holly leaf miner, *Phytomyza ilicis* (Curt.)	Victoria	1936	England	1,795
		Saanich	1937	"	1,306
		Saanich	1938	"	70
		Victoria	1938	"	3,188
		Vancouver	1939	"	852
Triaspis thoracicus Curt.	Pea weevil, *Bruchus pisorum* (L.)	Armstrong	1942	Europe	2,850
		Salmon Arm	1942	"	914
Trichomalus fasciatus (Thoms.)	Cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.)	Dewdney	1949	"	108
		Sardis	1949	"	90
Xenocrepis sp.	Cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.)	Dewdney	1949	"	1,063
		Sardis	1949	"	208
Zarhopalus corvinus (Gir.)	Grape mealybug, *Pseudococcus martimus* (Ehrh.)	Victoria	1939	U. S. A. (Belleville) [3]	88
		British Columbia	1940	"	1,707
Zenillia nox Hall.	Larch sawfly, *Pristiphora erichsonii* (Htg.)	Hosmer	1935	Japan	1,112
		Rosen Lake	1935	"	153

In addition to the importation of beneficial insects into British Columbia, the Biological Control Investigations Unit has obtained 21 parasite species in the Province for distribution against 8 pest species in other provinces. Many of the parasites obtained in British Columbia for distribution elsewhere in Canada were native species, but 5 of them were imported species that had become established and were sufficiently numerous to warrant collection for redistribution. The 5 species are listed in Table III.

TABLE III

Parasites imported into British Columbia and redistributed to other provinces of Canada.

Parasite	Year of Release in B.C.	Number of Release Points	Size of Colonies	First Date of Redistribution	Province
Apanteles solitarius (Ratz.)	1933	1	737	1940	Nfld.
Meteorus versicolor (Wesm.)	1934	1	520	1942	Nfld.
Mesoleius aulicus (Grav.)	1934-36 1941-42	11	49-1861	1944	Nfld., Ont., Man., Sask.
Ascogaster quadridentata Wesm.	1937-39	5	34-4377	1945	P.E.I., N.S., N.B., Que., Ont.
Glypta haesitator (Grav.)	1938-39	3	734-809	1945	P.E.I., N.S., Que.

There has been a considerable amount of theorizing by those who are interested in biological control problems regarding the optimum size of parasite colonies necessary to ensure establishment and the length of time required to build up an effective parasite population. Table III indicates that for some species at least, the release of small colonies under favourable conditions may result in the establishment and reasonablly rapid increase of parasites. It is significant that only one colony of *Apanteles solitarius* and of *Meteorus versicolor* was released in British Columbia, and from the single colony of 737 specimens of *Apanteles solitarius* and 520 specimens of *Meteorus versicolor* the former had increased sufficiently in 7 years and the latter in 8 years to warrant collection for redistribution in other provinces of Canada. This indicates that the original colonies were effective species well suited to climatic conditions in the new environment, and that they were properly handled prior to and during their release in the field. Probably the most important factor was that there was an abundant host supply and their release was timed to synchronize with the right stage of development of the host for parasitism.

Further evidence of the establishment of a small colony of parasites was obtained in 1949. A survey of the holly leaf miner in Vancouver and the surrounding districts revealed that the parasite *Opius ilicis* Nixon was present at 13 collection points. This parasite was originally released in the area in 1939 and the single colony consisted of only 4 males and 6 females.

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COLEOPTERISTS AND COLEOPTERA COLLECTIONS IN THE PACIFIC NORTHWEST

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(Read before the Entomological Society of British Columbia, March 18, 1950)

Last May I finished the first draft of the text of Part I, the first 650 species, of my **Coleoptera of the Pacific Northwest.** The manuscript was based primarily on a study of my own collection together with some correspondence with Mr. Gordon Stace Smith of Creston, B.C., Mr. Kenneth M. Fender of McMinnville, Ore., and Mr. Merton C. Lane of Walla Walla, Wash. My next job was to check my account against as much additional Northwestern material as possible, to accomplish which I proposed to visit the various Northwestern collections, check off the readily verified Northwestern species, and borrow for identification the unnamed or doubtfully named species. My paper today is a brief account of my travels in the furtherance of this objective, and is offered in the hope that it may throw some light on the status of one aspect of Northwestern entomology in the year 1949.

My first trip was into northwestern Oregon, and my first visit was to Oregon State College in Corvallis, June 16 and 17. The beetle collection is housed in trays in about 150 glass topped drawers. It is in charge of Dr. W. J. Chamberlin, who has taught forest entomology at the College since 1916 and is the author of several important entomological books, the most recent being a text on **Insects Affecting Forest Products and Other Materials.** He has specialized on Buprestidae and Scolytidae, his Buprestidae having recently been sold to the California Academy of Sciences. Oregon specimens in the College's collection are only moderately numerous, and I came to feel that my own collection of Oregon beetles is virtually as representative as theirs. The individual specimens are, however, curated with great care, each specimen bearing a determination label together with the name of the determiner. Elsewhere in the Northwest I found this procedure employed only at the University of Idaho and by Stace Smith.

In Corvallis I stayed with Frank Beer, who took a Master's degree under my direction in 1939, and, after teaching high school for a number of years at Grants Pass and Salem, has been instructing in general science at the Oregon State College. Beer has a small but beautiful collection, primarily of Buprestidae, but likewise of Scarabaeidae (including rare Oregon Pleocoma material), Elateridae, and Cicindalidae. Beer took me on a delightful collecting trip the second afternoon to Mary's Peak, 4097 feet high, about 15 miles west of Corvallis.

June 18 and 19 I spent with Kenneth Fender in McMinnville, Oregon. Fender is a rural mail carrier, and both he and his wife, Dorothy, are enthusiastic naturalists and the authors of numerous papers. Their interesting home on the southern outskirts of town, by the side of an inviting creek, is overrunning with zoological material. Dorothy specializes on earthworms. Both she and Kenneth specialize on the Lycidae-Lampyridae - Cantharidae group of beetles, and I hope they will do the portion of these families in my book. Kenneth likewise has a general collection of Oregon beetles—probably the best in existence—arranged in trays in 20 or 30 large insect boxes. Sunday we had excellent collecting in the Yamhill River bottom near Dayton.

My second trip was east of the Cascade Mountains. On July 24 I drove to Walla Walla where I stayed with M. C. Lane, who has been in charge of wireworm investigations in eastern Washington for the United States Bureau of Entomology and Plant Quarantine for 30 years. Lane became interested in beetles through Dr. E. C. Van Dyke, and is one of the most energetic, persistent, and expert beetle collectors known to me. His general beetle collection (mostly of Northwestern material) numbers over 100 insect

boxes, about three-fourths Adephaga, and his Elateridae, in which he has specialized, are arranged in trays in about 30 drawers and about 25 insect boxes, including many undescribed species. Lane is today one of the foremost authorities on both the taxonomy and biology of the Elateridae, and I hope that he will do the Elateridae in my book. Two of Mr. Lane's associates, Horace P. Lanchester and Edward W. Jones, have beetle collections, Lanchester likewise specializing on the Elateridae.

In College Place I visited Walla Walla College. This is a Seventh Day Adventist school. Their zoologist, Dr. Ernest Booth, is beginning an insect collection, having 17 drawers and 25 or 30 boxes of beetles. I did not meet Dr. Chalmer Chastian of Dr. Booth's staff, but last November I studied a collection of Blue Mountain Scolytidae made by him; but I did meet Gayle H. Nelson, one of Dr. Booth's graduate students, who had about 50 boxes of beetles, and is greatly interested in them. Nelson is located this year at Washington Missionary College, Takoma Park, Maryland; but he hopes to return to the Northwest. All in all, the Seventh day Adventists are doing right well by the study of beetles!

July 26 Lane drove Lanchester and me to Wallowa Lake in northeastern Oregon. There we met James H. Baker, a grocer of Baker, Ore. Mr. Baker has a very fine collection of Northwestern Geometridae, but under Lane's influence, he has been collecting Elateridae and Carabidae. I am urging him to begin accumulating beetles in general against the day when I shall want to borrow them for my **Coleoptera of the Pacific Northwest.** Baker is another very energetic fellow, and at Wallowa Lake he and Lane soon disappeared *up* the trail, leaving Lanchester and me far far behind! The day was only middling, but we got our share of beetles.

At Pullman, Wash., July 27-28, I stayed with Dr. Maurice T. James, the dipterist, who is in charge of the insect collection at the State College of Washington. The beetles are in trays in about 170 drawers plus 60 or 75 boxes of unnamed specimens. They represent the accumulation of many years and successive curators: C. V. Piper, A. L. Melander, J. F. G. Clark, R. D. Shenefelt, R. L. Webster,—but none of these men have been coleopterists. Since my coming to the state in 1927, I have always found the State College most cooperative and have felt free to use the collection just as though it were my own.

In the afternoon James and I drove to the University of Idaho at Moscow, eight miles away. The beetle collection there is arranged in trays in about 60 not too densely filled drawers and some 25 boxes of unnamed specimens and is in charge of Prof. H. C. Manis. Likewise in the Department of Entomology I met A. S. Waltz and Wm. F. Barr, both of whom lent me material (about an insect box each) from their private collections. Barr is especially interested in Buprestidae, and is this year on leave working on his doctorate at the University of California.

In the evening, James took me to call on N. M. Downie. Downie is doing personnel work in the Department of Education at the State College of Washington, but he is coleopterist on the side! His collection numbers about 16 very crowded drawers and a dozen boxes. It includes an extensive series of species that he collected in Turkey, but he is giving most of this material to me and to the State College, and is concentrating on Nearctic specimens.

June 28 I drove north, arriving after dark at the home of Gordon Stace Smith, a mile or so north of Creston, B. C. I had visited Stace Smith first the previous September, and was looking forward to working with him again in his spacious living room with its windows looking westward over the broad expanse of the Kootenay Valley with the Nelson Range of mountains beyond. It made one itch to go collecting, but I reflected that the coleopterological exploration of this corner of the Northwest is in most competent hands.

Mr. Stace Smith is a retired mining foreman and had formed two beetle collections; nearly a hundred boxes of beetles from British Columbia, where he

has lived most of his life, and about 45 boxes of beetles from Quebec, collected during a five years sojourn in that province. The latter collection, however, he was selling to the California Academy of Sciences to give him increased facilities for the British Columbia series. Stace Smith's collection of British Columbia beetles is probably the best extant collection from the province.

We got to work on the beetles almost as soon as I arrived, and by the next afternoon had finished checking the portion of his collection on Adephaga. The next morning I was once more under way. The afternoon I spent with Loyal Weitz in his home on the south side of Spokane. Mr. Weitz is in charge of the Underwood Typewriter Agency in Spokane. His avocational interest in biology has crystallized on the beetles, of which he is forming a collection, especially encouraged by Mr. M. C. Lane. Mr. Weitz is the sort of person who would be particularly helped by a general handbook of the beetles of the region.

That same evening I had dinner with Prof. and Mrs. Robert W. Rogers of the Eastern Washington College of Education in Cheney. Rogers had taken a Master's degree under my supervision in 1947, and, while not himself forming a beetle collection, has been most helpful in supplying me with specimens from the vicinity of Cheney and north Idaho. The next morning I drove to Seattle after a most enjoyable and profitable week.

No survey of Northwestern beetle collections could be complete without a visit to the California Academy of Sciences in San Francisco. Consequently, on Aug. 14, Estelle (Mrs. Hatch) and I left for the south. The second night out, at Medford, Oregon, we called on Mr. Fred Lawrence, for whom I had named some beetles back in the thirties. Lawrence is a sign painter by trade, an artist and a collector of butterflies and beetles by avocation. He has 20 or 25 drawers of beetles, mostly from Medford, in nicely constructed little wooden trays. Due to lack of contact with others of similar interest and the absence of usable literature from which he might have made his own identifications, he has lost most of his former interest in his collection. A proper reference book on our beetle fauna might well have turned him into a contributor to our science.

After an hour or so with Mr. Lawrence, we called on Mr. L. G. Gentner. Gentner is entomologist at the Southern Oregon Experiment Station at nearby Talent. At home he is a specialist on flea beetles, having 50 or 75 boxes of specimens, including nearly all known North American species, many of them undescribed. I have hopes that Mr. Gentner will be willing to write the portion on Alticinae in my **Coleoptera of the Pacific Northwest.**

At the University of California at Davis we called the next afternoon on Mr. A. T. McClay. McClay is a preparator in the Department of Entomology and an inveterate beetle collector, having a couple of hundred boxes of mounted and much unmounted material. While an insecticide salesman some years back, he collected extensively around Medford, Ore., and I have this winter had the privilege of studying a box or so of his Oregon Carabidae.

The next morning (Aug. 17) we arrived at the California Academy of Sciences, and were given a most cordial welcome by Dr. Edward S. Ross, curator of insects, Mr. Hugh B. Leech, who has charge of Coleoptera, and Dr. Edwin C. Van Dyke. At the Academy of Sciences is one of the world's great beetle collections. It contains about a million and a half specimens in about 1500 drawers and 500 to 1000 boxes. Its basis is the collection of Dr. Van Dyke, who gave his collection to the Academy in 1924, with the understanding that he would have full use of it during his life. And still, at the age of 81, Dr. Van Dyke was coming to the Academy every day to work on his collection. Van Dyke's example induced Dr. F. E. Blaisdell (1862-1946) and others to take similar action.

The Northwestern material in the Academy derives largely from the collections of Dr. Van Dyke and Ralph Hopping, and from Hugh Leech's hydrocoleoptera. Van Dyke came first to the Northwest with the Sierra Club in 1905, when they camped at Paradise

Park on Mt. Rainier before there was anything but a trail into the area; and every few years since, he has made additional excursions into the region, his collecting being confined for the most part to south of the international border.

Ralph Hopping (1868-1941), a former member of this Society, from 1919 to 1939 was entomologist in charge of the Dominion Forest Insect Laboratory at Vernon, B. C. He assembled an extensive collection of Coleoptera, much of it from British Columbia, that came to number about 10,000 species and 97,000 specimens. With the exception of a portion belonging to the Vernon laboratory, it was purchased by the California Academy in 1948, and is gradually being absorbed in the general collection of the Academy.

Hugh Leech will be remembered by many here as the energetic and efficient secretary and editor of our Society. Since 1947 he has been happily employed as associate curator of insects at the Academy. He lives at rural Mill Valley, about 12 miles north of the Academy across the Golden Gate Bridge. His collection of about 130 boxes of water beetles, rich in British Columbia material, has been transferred to the Academy.

After returning from California, there remained only a trip into southwestern British Columbia to complete my survey of Northwestern beetle collections. Taking advantage of our Thanksgiving holiday, Estelle, our daughter, and I took the night ferry for Victoria. Nov. 24 I spent with Mr. G. A. Hardy at the Provincial Museum. Mr. Hardy has a collection of 50 or more double boxes of beetles, and has specialized, as we all know, on Cerambycidae, Buprestidae, and Elateridae. The museum has several collections that have been given to it, but so far these remain in their original boxes and have not been organized into a single whole.

The next day we drove north along Vancouver Island nearly to Wellington where we had lunch with Mr. Richard Guppy, Mrs. Guppy, and her sister. Mr. Guppy is another member of this Society. He has a chicken ranch, and has a collection of Vancouver Island Coleoptera and Lepidoptera. His beetles fill about a dozen boxes and drawers and is quite complete, considering the restricted area of his specialization. Mr. Guppy sells Vancouver Island insects to interested parties.

That evening we ferried over from Nanaimo to Vancouver, where we were entertained by Prof. and Mrs. G. J. Spencer. Prof. Spencer is in charge of the insect collections at the University of British Columbia. The beetles were arranged in 25 or 30 drawers some years ago by Mr. George R. Hopping, son of Ralph. Prof. Spencer introduced us to W. Lazorko, M.D., a refugee from Lemberg, Galicia, who had been in Canada about 18 months, in Vancouver about 11 months. He has a collection of some 300,000 beetles, 50,000 of them mounted, and 5000 or 6000 specimens from Vancouver. He is specially interested in the Carabidae and may well be heard from scientifically when he becomes settled in the New World.

This concludes my account. I do not assert to have mentioned all the Coleopterists in the Pacific Northwest, but only those I encountered in 1949.

UPON THE MATING HABITS OF THERMOBIA DOMESTICA PACK (Thysanura: Lepismidae)*

G. J. SPENCER

University of British Columbia, Vancouver, B. C.

In the course of a study of the bionomics of *Thermobia domestica* Pack, the firebrat, it was frequently noted that females follow males for long periods of time. Under the impression that this chase was some part of mating reactions, the performance was watched until it reached a climax. The process or "love-dance" may last one and one-half to two hours and is somewhat as follows:

* Contribution No. 294, Department of Entomology, University of Illinois, being a revised portion of a Master's Thesis presented to the Department.

The larger female follows the smaller male which seems very restless, moving from place to place after a few minutes in each position. As soon as the male comes to rest, it turns and faces the female and both touch their antennae at close quarters with many rapid movements and then stay quiet. The male then turns again and moves away, followed by the female and the process is repeated over and over again for long periods. In its wanderings around the cage amongst many other firebrats, the male may get separated from the female by a space of several inches and the angle or corner of the cage. The female then runs around in all directions and seems to pick up the trail of the male very much after the fashion of a bloodhound.

Now at the tips of the caudal sterna, the coxites of Walker or coxopodites of Snodgrass which flank the base of the male pseudocercus, are short unbranched setae in connection with relatively enormous, simple glands occurring in two series. There are six glands on each side dorsally and three on each side ventrally; the glands from the tip to the base of the seta above it, average 0.134 mm. long by 0.016 to 0.02 mm. broad. It is possible that either these glands or the eversible vesicles which occur on the coxopodites mesad of the styli, function at mating time as scent glands and provide the scent which the female follows when in pursuit of a male.

This love dance has been watched several times for an hour at a time but no climax took place. On five occasions, however, its completion was observed. The climax occurs when the movements of the male become more rapid and he does not run away from the female but turns around in a circle on a short axis, pausing every few seconds to touch antennae with those of the female while the latter now remains perfectly quiet, crouched low on the floor with antennae lying straight ahead of her. Each time the male turns around away from the female, he raises the tip of the abdomen in the air and waves it about. Finally on the under side of the tip of the abdomen there suddenly appears a semi-transparent pyriform spermatophore about one millimeter in length with the broader end discharged first and pointing caudad. In no more than three seconds from the moment of its appearance, the spermatophore is deposited on the floor just about three quarters of an inch directly in front of the female. The male then turns immediately, touches the female's head with his antennae which move at great speed in short, rapid jerks and turning abruptly aside, he moves away. Body raised up on the legs, the female then moves straight forward, passes over the spermatophore and presses the base of the ovipositor on it. Two very small drops of liquid are present at the base of the ovipositor and the spermatophore adheres to the abdomen of the female. She adjusts it by one or two slight touches of her mouth parts and as nearly as could be seen, makes a rent in it with the tips of the maxillae; a small quantity of liquid extrudes without, however, changing the shape of the object.

The contents of the spermatophore are absorbed by the female over a period of several hours. On three occasions when the absorption was noted it took one and one-half hours, four and one-half hours and overnight respectively. The walls of the spermatophore then drop off and are likely to be eaten by the female if not taken away from her. Microscopic examination of the empty receptacle showed no spermatozoa, only a thin chitinous case and some gelatinous material.

If there is any doubt as to this being an externally deposited spermatophore, the matter could readily be solved by removing it immediately after deposition and examining the contents microscopically for active spermatozoa. Since the whole procedure was observed only five times and it was necessary to determine the pre-oviposition period, this examination was not made.

The pre-oviposition period as observed in two instances, is from one and one-half to four and one-half days; the female that absorbed the contents of the spermatophore in the latter period laid eggs thirty-six hours afterwards.

Apart from the observations and findings reported above, it would be difficult for these firebrats to copulate in

the normal manner of insects, in view of the extreme shortness of the male aedeagus which is relatively a minute, latent, oval tube; the entire absence of secondary copulator mechanisms or "grappling hooks," and the long, closely-knit base of the dorsal and ventral valvulae of the female ovipositor, between which it would seem impossible for such a short aedeagus to penetrate.

A COMPARISON OF POTATO TUBER DAMAGE BY TWO FLEA BEETLES, EPITRIX TUBERIS GENT. AND EPITRIX SUBCRINITA (LEC.) (COLEOPTERA: CHRYSOMELIDAE)

H. R. MACCARTHY

Dominion Entomological Laboratory, Kamloops, B. C.

In the course of a recent investigation into control of flea beetles on potato, at Kamloops, B. C., the question arose as to whether the western potato flea beetle, *Epitrix subcrinita* (Lec.), caused the same type of damage to potato tubers as its close and more numerous relative, the tuber flea beetle, *E. tuberis* Gent. A small experiment was set up at the Dominion Laboratory of Plant Pathology, University of British Columbia, to make a comparative study of the damage caused by the two species.

Collections of the two species by C. L. Neilson and D. G. Finlayson, Dominion Field Crop Insect Laboratory, Kamloops, B. C., from potato fields near Kamloops were sent to Vancouver. A group of 12 individuals of each species was placed on a potato plant in each of three cages. The external sexual characteristics being difficult to see in living specimens, the ratio of males to females was not known. Each group was a random sample.

The cages were developed from a type in use at the University of California. They were cylindrical, 30 inches high, the ends being 15 inches in diameter and made of 5-ply wood, with a 5½-inch hole in each. The ends were joined by four uprights and between two of these was a 9-inch pane of glass. The remaining three side panels were covered with organdy. The potted, caged plant grew up through the hole in the bottom. Cotton batting made an insect-tight filler at the rim where the cage rested on the pot. The host plants were White Rose potatoes from a single parent plant, growing in 10-inch pots. At the start of the experiment they were about 2 feet high. The soil moisture was maintained from water poured into saucers in which the pots were set. The cages were kept in a greenhouse and inspected daily. The beetles were introduced into the cages on July 29, and taken out on October 6. Emergence of second-generation adults started during the last week in September but was not complete by October 6.

When the soil was washed from the root systems, it was found that both species severely damaged the root, rhizome, and tuber. Tunnels up to four per inch were found in the rhizomes. In one cage containing a heavy population of *E. tuberis* some of the rhizomes were completely cut off. In all the cages many of the fibrous roots appeared to be cut and shortened. A thin peeling was taken off the tuber before damage marks were counted and for each species 50 tunnels in the tubers were chosen at random and measured at a depth of approximately 1 mm. The average length of tunnel in each instance was 2.5 mm. The range was from 1.0 mm. to 5.0 mm., with 40 per cent 2.0 mm. long and the frequency distributions were almost exactly the same for the two species. There were few surface tracks.

Under the conditions of the experiment, *Epitrix subcrinita* produced a substantial amount of tuber injury, practically identical in nature with that produced by *E. tuberis*. Both species also damaged roots and rhizomes severely. It does not follow, however, that the same results would be secured in experiments conducted in the field, or in field cages.

SCIENCE NOTES

Orthezia occidentalis, an Ensign coccid, in British Columbia (Homoptera: Ortheziidae). In the middle of October, 1945, Mr. Peterski, bus driver of Powell River, who lives a short distance out of that town, looked out one morning and saw what looked like a light fall of snow on two acres only of one of his fields which had been cleared but not cultivated. A light wind was blowing but the morning was not cold so Mr. Peterski went out to investigate. He found that the white covering consisted of moving particles, so he took some in to Dr. Boxall of Powell River Clinic. Being very interested in natural history, Dr. Boxall went out to the field and found that the alleged snow consisted of small, flat insects shaped like bedbugs which were covered all over with tiny, overlapping particles of white wax. By the time he got to the field, the insects had all disappeared under grass and moss and could be found only at ground level. He collected a number and sent them to me. I identified them tentatively as **Orthezia occidentalis** Douglas and forwarded them to the National Collection at Ottawa where a specialist confirmed my identification, adding that there is one record of it from Kaslo and one from Victoria, made by Mr. Downes. Professor "Essig in College Entomology" reports it from Alaska where it feeds on the roots of plants.

This snow-white species must have fed on the roots of grasses or plants at Powell River where it apparently developed unseen until it increased enormously and crowded to the tops of low vegetation in such numbers as to whiten the field.

The **Orthezia** scales are almost entirely tropical species of which one, **Orthezia insignis** Douglas, has become a greenhouse pest which is widely distributed by commerce. So far, I have taken only one other native species, as yet unidentified, of which I collected an isolated colony on sagebrush at MacGillivray's, halfway between Lytton and Lillooet, in July, 1931.—G. J. Spencer, Department of Zoology, University of British Columbia.

Further note on Orthezia occidentalis—By a curious coincidence the specimens recorded from Kaslo, B. C., were in the possession of the Editor when the above note by Professor Spencer was received. They were included in a small collection of Hemiptera made by the late A. W. Hanham, now the property of the Provincial Museum. There were also some specimens with a date, but no locality label, which were probably taken at Duncan. **Orthezia occidentalis** is a much commoner insect than is generally supposed but owing to its habit of living down among the crowns or clumps of grass it is seldom seen if not searched for. It is common in Victoria and probably occurs at many points on the east coast of Vancouver Island and the adjacent mainland.—W. Downes, Victoria, B. C.

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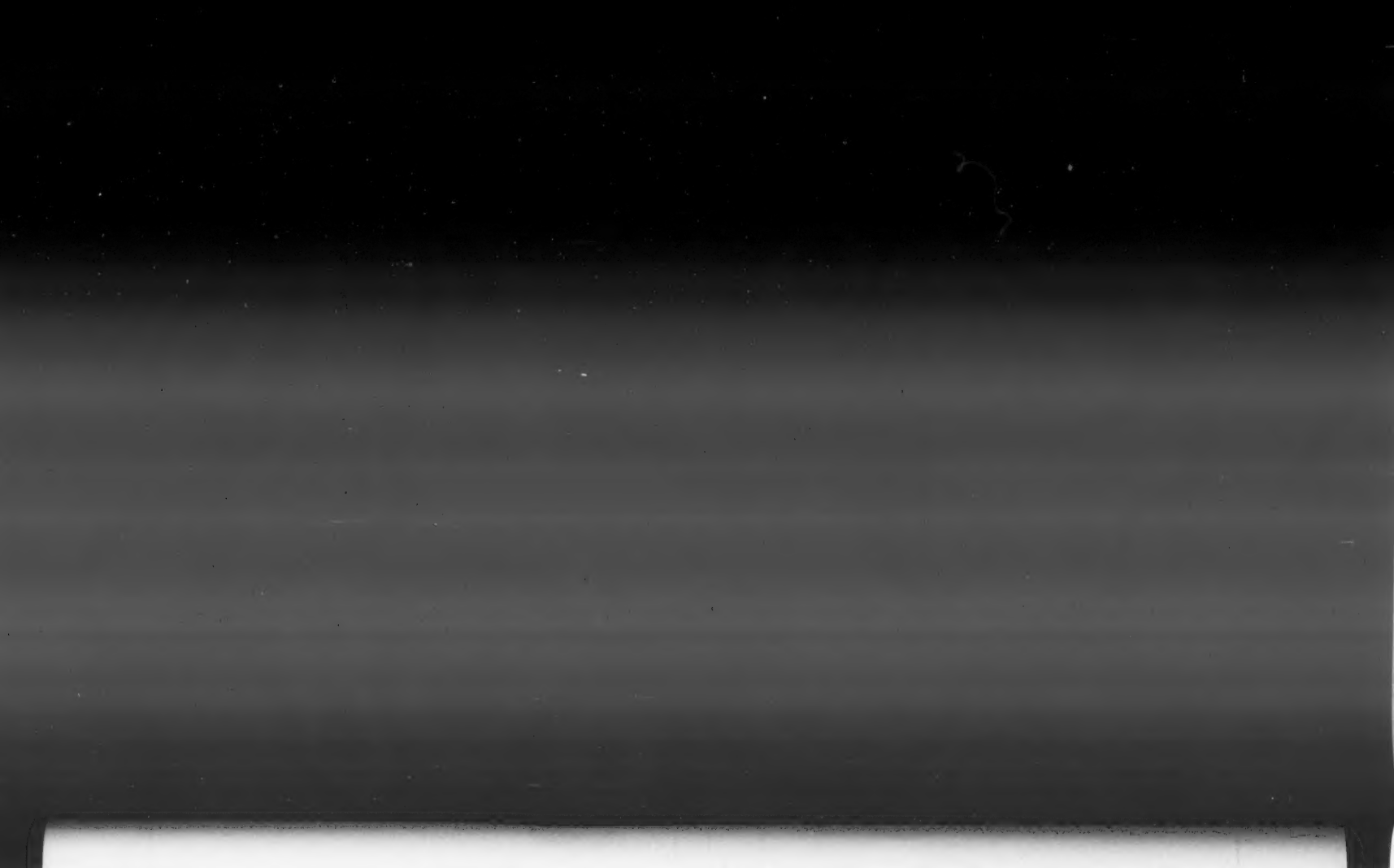

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